AGRICULTURAL PRODUCTIVITY AS A COMPONENT IN THE LEVELS OF REGIONAL DEVELOPMENT IN BIHAR

ABSTRACT

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

GEOGRAPHY

BY

TARIQ MAHMOOD USMANI

Under the Supervision of

DR. SHAMSUL HAQUE SIDDIQUI

(READER)

DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)

1999

ABSTRACT

Introduction

Agriculture in India dates back to the time of Indus Valley Civilization. Ever since it has continued to be the leading occupation and the main stay of the population of the country. About three fourth of the country's population lives in rural areas and carries out agricultural activities.

The present work is a study of the regional patterns of agricultural productivity, levels of regional development and their interrelationships as they obtain in the State of Bihar, the area under study. The study examines regional patterns of agricultural productivity in detail in the area under study and analysis their socio-economic and environmental correlates which are likely causes of spatial variations in agricultural productivity. Agricultural productivity is viewed as a measure of efficiency with which the agricultural system in the region works. As, such variations in the agricultural reflects disparities in the use of agricultural resources in the area at the level of districts. Since agriculture is the mainstay of the economy of the region, where about 80 percent of the population is engaged in agricultural activities, differences in the agricultural productivity may be taken as the differences in the economic progress of the region. In other words, if it is presumed that economic and social development go hand in hand, the agricultural productivity in the region can be taken as the major component of the regional development.

In the regional analysis of development one comes across regions which are well developed and the people in such region enjoy reasonable standard of living while in others, resource utilization and development is low owing to historical circumstances or otherwise, resulting in the under development of the region whereby people have a poor standard of living. The problem of imbalance in regional development thus assumes a great significance. Regional development, therefore, is interpreted as intra-regional development designed to solve the problems of regions lagging behind. The first connotation of regional development is economic in which the differences in growth, in volume and structure of production, income, employment are taken as the measure of economic progress. However, recently it has been argued that merely economic criteria can not explain the level of development which is a multidimensional concept. Therefore, such variables or criteria should also be employed which indicate progress on technological, social and cultural fronts. Thus development means progress throughout the society. However, at the base of development process lies progress in different sectors of the economy.

Regional development in an overwhelmingly agricultural situation can only be achieved by developing agriculture and reducing gaps between regions with regard to the efficiency of the agricultural system. Progress in agriculture releases resources, labour as well as capital for use in industry and services. Progress in agriculture also leads to the modernization and social development and better level of living through education and generating propensity to consume other than agricultural goods.

Hypothesis

Progress in agricultural productivity and levels of development thus be hypothesized to be interrelated. Testing of this hypothesis in the area under study is the crux of the research problem. Findings of this research may help to design plans and formulate policies for the development of the area in general and reducing disparities at micro level in particular.

Aims and Objectives

The objectives of the study as stated earlier is to delineate areas of high and low agricultural productivity, to delineate regions at varying levels of development and to examine the relationship between the agricultural productivity and levels of development.

Data Base and Methodology

Agricultural productivity is calculated by using data on area and production of all important crops grown in the region. The present study is based on secondary source of data for the year 1980-81 and 1990-91. The data for the calculation of productivity indices are obtained from Directorate of Statistics and Evaluation, Govt. of Bihar, Patna. A district has been taken as the unit of study. In order to analyse and measure levels of development a large number of variables (Appendix D) relating to agricultural development, urbanization and industrilization, infrastructure and amenities and social development are also taken from Directorate of Statistics and Evaluation, Govt. of Bihar, Patna for the year 1980-81 and 1990-91.

In the present study two analytical concepts of agricultural productivity and level of regional development are used. So far as agricultural productivity is concern there is not a single universally accepted method of measuring agricultural productivity. Different scholars have used different numerical methods to measure levels of agricultural productivity, at small areal units. In this study two methods of measuring agricultural productivity have been used. There are agricultural output per hectare of cropland (price weighted) and the methodology as given by W.Y. Yang. Regional development is measured on the basis of twenty variables. This is measured by factor analysis because loadings of variables on a factor (dimension) are their weights which are derived from their factual interrelationships. Factors are subjected to rotation to some theoretical criteria to make the factor structure more interpretable. The hypothesis of relationship between agricultural productivity and levels of development is tested by using coefficient of product moment correlation (r) and coefficient of determination (r^2).

Computation for these analysis was carried on Aligarh Muslim University's Vax-11 computing system which involves following steps:

1. Computation started with the transformation of original data matrix D for n observations on m variables into a standard score matrix z of n x m order.
2. From Z matrix m x m order correlation matrix R was calculated which contained product moment correlation coefficients.

3. This correlation matrix was resolved into a factor matrix A of m x r where r was number of fact extracted. The program employed can extract as many factors as the number of variables. Therefore, in the first instance all the factors were extracted. Histogram of the cumulative percentages of the variance explained by the successive factors and cumulative number of factors was constructed. By inspecting rate of change in the explanation of variation by factors number of factors to be retained was determined.

4. Since original variables retained were not readily interpretable, the factor loading matrix A was rotated according to normal varimax criterian to reproduce a new factor loading matrix. The criterion employed rotated the factor matrix to such a position where a minium possible number of variables loaded high on each factor. The factor structure, thus, became simpler and easily interpretable.

5. From the matrix multiplication standardized score matrix of n x m order and rotated factor matrix A of m x r order, a factor score matrix A of m x r order, a factor score matrix F of m x r order was obtained. Factor scores were then standardized to zero mean and unit variance. These factors scores provided a measure of position of each district on the new factors.

Chapter Scheme

The present work besides introduction and conclusion has been grouped into six chapters. Chapter one tries to sum up the geographical setting of Bihar, with reference to relief, drainage, climate and soil. In chapter two conceptual framework of agricultural productivity and the methodology of measurement of agricultural productivity is given. In the third chapter focus is onto regional development elucidating concepts of regional development and its measurements. The chapter four deals with the pattern of agricultural productivity. Dimensions of regional development are analysed in the fifth chapter. The sixth chapter of the thesis is devoted to the analysis of relationship between agricultural productivity and regional development. In the conclusion suggestions have been made to minimize the regional disparities in the levels of agricultural productivity and regional development in the area under study.

Conclusion and Suggestion

The overall analysis of the study reveals the fact that there is inverse relationship between agricultural productivity and regional development in Bihar. That is, higher levels of development are not associated with the higher level of agricultural productivity and vice versa. The overwhelming importance of agriculture in Bihar's economy can not be over emphasized but agricultural productivity in Bihar, the study area, appears to be less significant or weak factor of urbanization and modernization. The ever increasing population is exerting a great

pressure on land and adversely affecting the man land ratio. As agriculture is of intensive subsistence type, farmers grows a large variety of crops and production is just sufficient to maintain their families, only a small surplus is marketed locally to buy agricultural implements and other necessary items for their domestic use.

The overall productivity of Bihar is generally low but in northern and central Bihar, where agriculture is the only occupation of the majority of population, agricultural productivity is comparatively high as compared to southern Bihar. This is due to high fertility of soil, better irrigation facilities and due to diffusion of modern inputs in some parts of northern and central Bihar. Inspite of high agricultural productivity the regional development in the area is very slow. This may be due to high growth of population which leads to the low investment in the agricultural and other sectors. The extra production being consumed by extra population. Contrary to this, the southern Bihar plateau, which is the store house of large number of minerals, both mining and agriculture are the main occupation of the people. The agricultural productivity is generally low as compared to northern and central Bihar. The soil layer of southern Bihar is thin and lies over a rocky stratum and therefore it become burnt during dry season resulting in low productivity. Besides, the topography of southern Bihar plateau is not suitable for growing all types of crops which is important to support large population of the area. As the agricultural productivity is generally low in southern Bihar it do not contribute to regional development of region.

It is generally found that the agricultural productivity as a measure of efficiency through various links has a strong bearing on the level of development but in Bihar, the area under study, the agricultural productivity as a component of regional development has a weak or no bearing on the levels of regional development.

AGRICULTURAL PRODUCTIVITY AS A COMPONENT IN THE LEVELS OF REGIONAL DEVELOPMENT IN BIHAR

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

GEOGRAPHY

BY

TARIQ MAHMOOD USMANI

Under the Supervision of

DR. SHAMSUL HAQUE SIDDIQUI

(READER)

DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)

1999

Phone : 400683
DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH—202002

CERTIFICATE

I certify that the Ph.D Dissertation on 'Agricultural Productivity as a component in the levels of Regional Development in Bihar' has been completed by Mr. Tariq Mahmood Usmani under my supervision and recommend that it may be forwarded to the examiner for evaluation.

Dr. Shamsul Haque Siddiqui
Department of Geography
AM.U., Aligarh.

Dedicated

to

my

Mother

ACKNOWLEDGMENT

I owe a sincere and deep gratitude to my supervisor, Dr. Shamsul Haque Siddique, Reader in the department of Geography, Aligarh Muslim University, Aligarh, who has always been gracious enough to give me valuable suggestions and guiding at every stage in the preparation of this thesis. I wish to express my thanks to Prof. Ali Mohammad, Chairman of the Department of Geography for providing all the necessary research facilities in the department.

I am extremely grateful to my teacher Prof. Mohammad Shafi, who has always been a source of inspiration for me. I express my sincere thanks to Mr. Jabir Hasan Khan for his spontaneous help whenever required.

I wish to express my thanks to Mr. Sanjeev Chauhan for his help in computer typing and Mr. Kausar and Mr. Irfan for cartographic assistance. Thanks are also due to all the staff members of the library, all the members of the Directorate of the Statistics and Evaluation, Agricultural Department, Registrar Cooperative Society, Government of Bihar.

I am also grateful to my colleagues Messers Habib, Aijaz, Ateeq, Tariq, Aziz, Anzar, Abid and Miss Lubna, and Miss Noorusahar for their timely encouragements. I am highly indebted to my parents and my brother who has always been the source of inspiration for my academic pursuits. I thank my wife, Seema

who kept me free from various household responsibilities and helped me in more than one way in the completion of this work.

Last, but not the least, I wish to thank University Grant Commission (UGC) for providing me financial assistance without which the present research work in the form of Ph.D. thesis could not be possible.

Tariq Mahmood Usmani

Aligarh
1999
1st July, 1999

(Tariq Mahmood Usmani)

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Agriculture in India dates back to the time of Indus Valley Civilization. Ever since it has continued to be the leading occupation and the mainstay of the population of the country. About three fourth of the country's population lives in rural areas and carries out agricultural activities.

The present work is a study of the regional patterns of agricultural productivity, levels of regional development and their inter relationships as they obtain in the state of Bihar. The study examines regional patterns of agricultural productivity in the area under study and analyses their socio-economic and environmental correlates which are likely causes of spatial variations in agricultural productivity. Agricultural productivity is viewed as a measure of efficiency with which the agricultural system in the region works. As, such variations in the agricultural productivity reflects disparities in the use of agricultural resources in the area at the level of districts. Since agriculture is the mainstay of the economy of the region, where about 80 percent of the population is directly or indirectly engaged in agricultural activities, differences in the agricultural productivity may be taken as the differences in the economic progress of the region. In other words, if it is presumed that economic and social development go hand in hand, the agricultural productivity in the region can be taken as the major component of the regional development.

In the regional analysis of development one comes across regions

which are well developed and the people in such region enjoy reasonable standard of living while in others, resource utilization and development is low owing to historical circumstances or other wise, resulting in the underdevelopment of the region whereby people have a poor standard of living. The problem of imbalance in regional development thus assumes a great significance. Regional development, therefore, is interpreted as intra-regional development designed to solve the problems of regions lagging behind. The first connotation of regional development is economic in which the differences in growth, in volume and structure of production, income, employment are taken as the measure of economic progress. However, recently it has been argued that merely economic criteria can not explain the level of development which is a multidimensional concept. Therefore, such variables or criteria should also be employed which indicate progress on technological, social and cultural fronts. Thus development means progress throughout the society. However, at the base of development process lies progress in different sectors of the economy.

Regional development in an overwhelmingly agricultural situation can only be achieved by developing agriculture and reducing gaps between regions with regard to the efficiency of the agricultural system. Progress in agriculture releases resources, labour as well as capital for use in industry and services. Progress in agriculture also leads to the modernization and social development and better level of living through education and generating propensity to consume other than agricultural goods.

Progress in agricultural productivity and levels of development may thus be hypothesized to interrelated. Testing of this hypothesis in the area under study is the crux of the research problem. Findings of this research may help to design plans and formulate policies for the development of the area in general and reducing regional disparities at micro level in particular.

The objective of the study as stated earlier is to delineate areas of high and low agricultural productivity, to delineate regions at varying levels of development and to examine the relationship between the agricultural productivity and the levels of development.

Agricultural productivity is calculated by using data on area and production of all the important crops grown in the region. The present study is based on secondary source of data for the year 1980-81 and 1990-91. The data for the calculation of productivity indices are obtained from Directorate of Statistics and Evaluation, Govt. of Bihar, Patna. A District has been taken as the unit of study. In order to analyse and measure levels of development a large number of variables relating to agricultural development, urbanization and industrialization, infrastructure and amenities and social development are also taken from Directorate of Statistics and Evaluation, Govt. of Bihar, Patna for the year 1980-81 and 1990-91. The area under study is a large region consisting of 31 districts in 1981 and 42 districts in the year 1991. This state has three distinct geographic regions, the North Bihar plains, the Central or South Bihar plains, and Southern Chotanagpur Plateau. The total geographical area of the state is 17.35 sq. km., with

a population of 86.3 million (Census 1991), and a high population density of 497 persons per sq.km.

Agriculture occupies an important place in the economy of India and more especially in the state like Bihar, where agriculture plays a dominant role as it not only provides food to 86.3 million persons but also supplies raw materials to numerous agro-based industries. About 80 percent of the total working population is directly or indirectly employed in agriculture. The increase in income levels and improvement in the quality of life of the majority of people in the rural areas is possible only by improvement of agricultural production and productivity, particularly small and marginal farmers. In Bihar agriculture is mainly of intensive subsistence type. Owing to great pressure of population, the average size of land holding is 0.93 hectares. There is an intense fragmentation of holdings and nearly 80 percent of land holdings are less than 2 hectares accounting for 30 percent of the total operational area.

In the present study two analytical concepts of agricultural productivity and level of regional development are used. So far as agricultural productivity is concern there is not a single universally accepted method of measuring agricultural productivity. Different scholars have used different numerical methods to measure levels of agricultural productivity, at small areal units. In this study two methods of measuring agricultural productivity have been used. These are agricultural output per hectare of cropland (price weighted) and the methodology as given by W.Y. Yang. Regional development in the

present study is measured on the basis of twenty variables. This is measured by factor analysis because loadings of variables on a factor (dimension) are their weights which are derived from their factual interrelationships. Factors are subjected to rotation to some theoretical criteria to make the factor structure more interpretable. The hypothesis of relationship between agricultural productivity and levels of development is tested by using coefficient of product moment correlation (r) and coefficient of determination (r^2).

Computation for these analysis was carried on Aligarh Muslim University's Vax-11 computing system which involves following steps:

1. Computation started with the transformation of original data matrix D for n observations on m variables into a standard score matrix z of n x m order.
2. From Z matrix m x m order correlation matrix R was calculated which contained product moment correlation co-efficients.
3. This correlation matrix was resolved into a factor matrix A of m x r where r was number of fact extracted. The program employed can extract as many factors as the number of variables. Therefore, in the first instance all the factors were extracted. Histogram of the cumulative percentages of the variance explained by the successive factors and cumulative number of factors was constructed. By inspecting rate of change in the explanation of variation by factors. Number of factors

to be retained was determined.

4. Since original variables retained were not readily interpretable, the factor loading matrix A was rotated according to normal varimax criterion to reproduce a new factor loading matrix. The criterion employed rotated the factor matrix to such a position where a minium possible number of variables loaded high on each factor. The factor structure, thus, became simpler and easily interpretable.

5. From the matrix multiplication standardized score matrix of n x m order and rotated factor matrix A of m x r order, a factor score matrix A of m x r order, a factor score matrix F of m x r order was obtained. Factor scores were then standardized to zero mean and unit variance. These factors scores provided a measure of position of each district on the new factors.

The present work besides introduction and conclusion has been grouped into six chapters. Chapter one tries to sum up the geographical setting of Bihar, with reference to relief, drainage, climate and soil. In chapter two conceptual framework of agricultural productivity and the methodology of measurement of agricultural productivity is given. In the third chapter focus is onto regional development elucidating concepts of regional development and its measurements. The chapter four deals with the pattern of agricultural productivity. Dimensions of regional development are analysed in the fifth chapter. The sixth chapter

of the thesis is devoted to the analysis of relationship between agricultural productivity and regional development. In the conclusion suggestions have been made to minimize the regional disparities in the levels of agricultural productivity and regional development in the area under study.

CHAPTER 1

STRUCTURE, RELIEF AND DRAINAGE

The state of Bihar (the area under study) extends approximately between parallels of 22° N to 27° 31' N latitude and meridians of 83° 20' E to 88° 17' E longitude. The state occupies an area of 173877 square kilometres of which 1.84 percent area was classified as urban. The maximum north-south length of Bihar is about 605 kilometres and maximum east-west width is about 483 kilometres. It is bounded by Nepal in its north, Uttar Pradesh in the west, Madhyapradesh on its south-west , Orissa on its south and West Bengal in its east.

According to the 1991 census , (For detail see Appendix A) the total Population of the state was 86374465 of which 13.14 Percent was classified as urban. During two intercensal periods , 1971-81 and 1981-91, growth rate of Population in the state was 24.06 and 23.49 percent respectively. According to the 1991 census, the general sex ratio, that is the number of females per thousand males, in the study area was 911. In the state 38.48 percent population was literate . The literacy rate among male was 52.4 percent while among females it was only 22.89 percent .

At the time of 1991 census, the state had 25619038 person as main workers which constituted 29.66 percent of the total population. The portion of cultivators and agricultural labourers to main workers was 80.70 percent , while the percentage of cultivators to main workers


BIHAR
ADMINISTRATIVE DIVISION
(1981)
WEST CHAMPARAN
EAST CHAMPARAN
SITAMARHI
GOPALGANJ
MADHUBANI
SIWAN
MUZAFFARPUR
DARBHANGA
SAHARSA
PURNIA
SARAN
VAISHALI
SAMASTIPUR
KATIHAR
BEGUSARAI
BHOJPUR
PATNA
NALANDA
MUNGER
BHAGAL PUR
ROHTAS
GAYA
NAWADA
AURANGABAD
SANTHAL PARGANA
HAZARIBAGH
GIRIDIH
PALAMU
DHANBAD
RANCHI
SINGHBHUM
40 0 40
Km
LOCATION OF BIHAR IN INDIA
INDIA
0 500
Km

Fig. 1

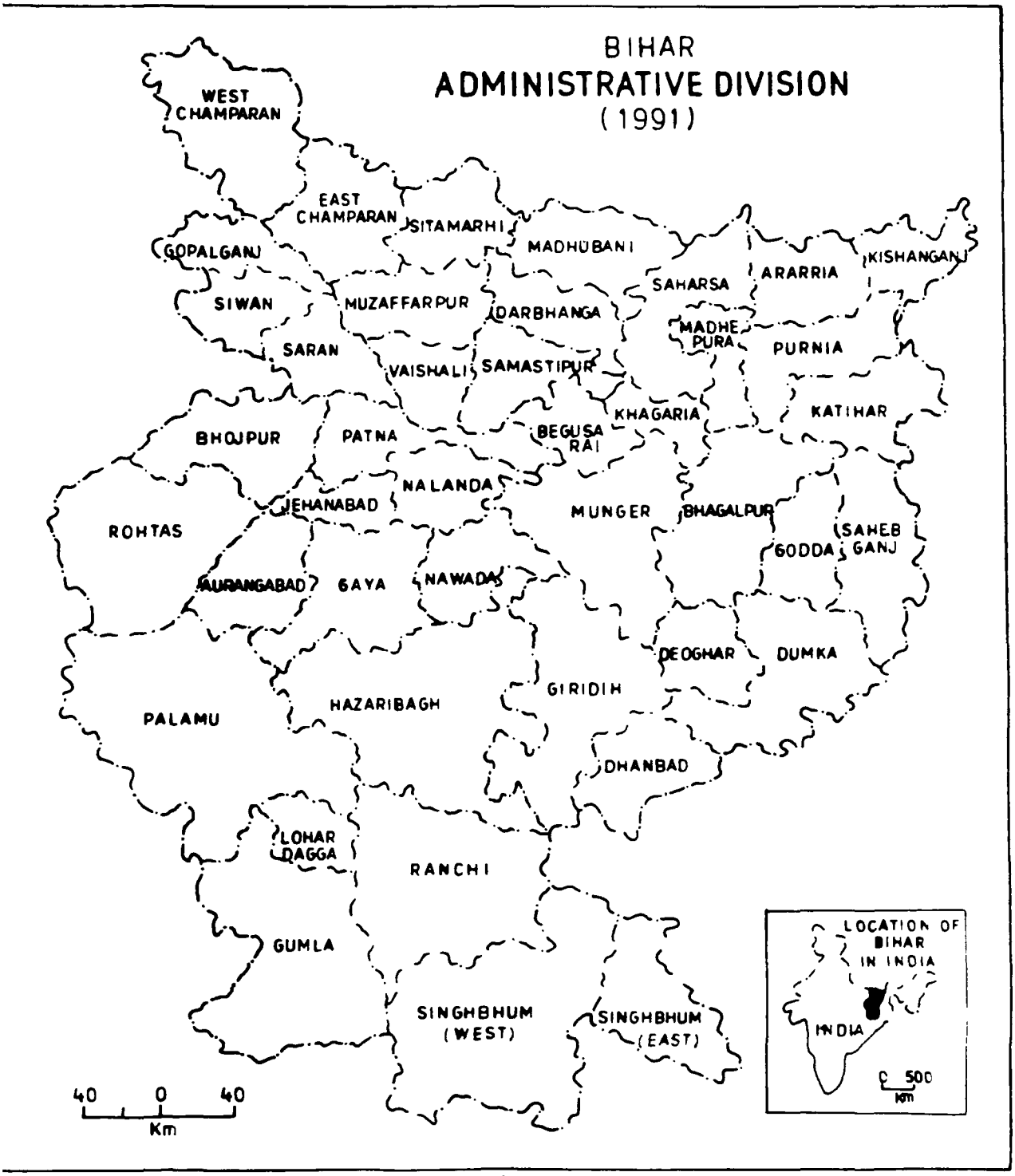

BIHAR
ADMINISTRATIVE DIVISION
(1991)
WEST CHAMPARAN
EAST CHAMPARAN
SITAMARHI
MADHUBANI
KISHANGANJ
GOPALGANJ
SAHARSA
ARARRIA
SIWAN
MUZAFFARPUR
DARBHANGA
MADHEPURA
PURNIA
SARAN
VAISHALI
SAMASTIPUR
KHAGARIA
KATIHAR
BHOJPUR
PATNA
BEGUSARAI
NALANDA
JEHANABAD
MUNGER
BHAGALPUR
SAHEB GANJ
GODDA
ROHTAS
AURANGABAD
GAYA
NAWADA
DEOGHAR
DUMKA
GIRIDIH
HAZARIBAGH
PALAMU
DHANBAD
LOHARDAGGA
RANCHI
GUMLA
SINGHBHUM (WEST)
SINGHBHUM (EAST)
LOCATION OF BIHAR IN INDIA
INDIA
0 500 km
40 0 40
Km

Fig. 2

was 43.57 percent , and portion of agricultural labourers to main workers was 37.13 percent.

RELIEF

Physically Bihar is divided into three unequal parts which have been described as follows:

1. Himalayan Foot Hills

There is a small hilly area in the north -western part of West Champaran district. This is apart of the well known extensive Siwalik Range of the Himalayan foot hills (Fig.3). This region covers an area of about 586 sq. kilometres and is roughly enclosed on the south by 152 metres contour line. The region consists of two different ranges of hills and intervening valleys, all parallel to the Nepal border in a north west to south east direction: (a) The southern range of low hills is called the Ramnagar *Dun* extending about 32 kilometres with an average width of 6-8 kilometres. The highest point is 241 metres near Santpur. (b) To the north east of Ramnagar Dun succeeds the Valley of Harha called the *Dun* valley which is only about 22 kilometres long and is distinctly higher than the main alluvial plain to the south of this hill region. (c) North of this valley lies the Sumeswar Range. The international boundary between India and Nepal run along the crest of this range. Its average width wither Bihar is 5-6 kilometres. The entire hill region in the north west of Bihar consists of relatively young sedimentary rocks of Late Tertiary times. Being young the are ill compacted and relatively soft, so that under a tropical humid climate they

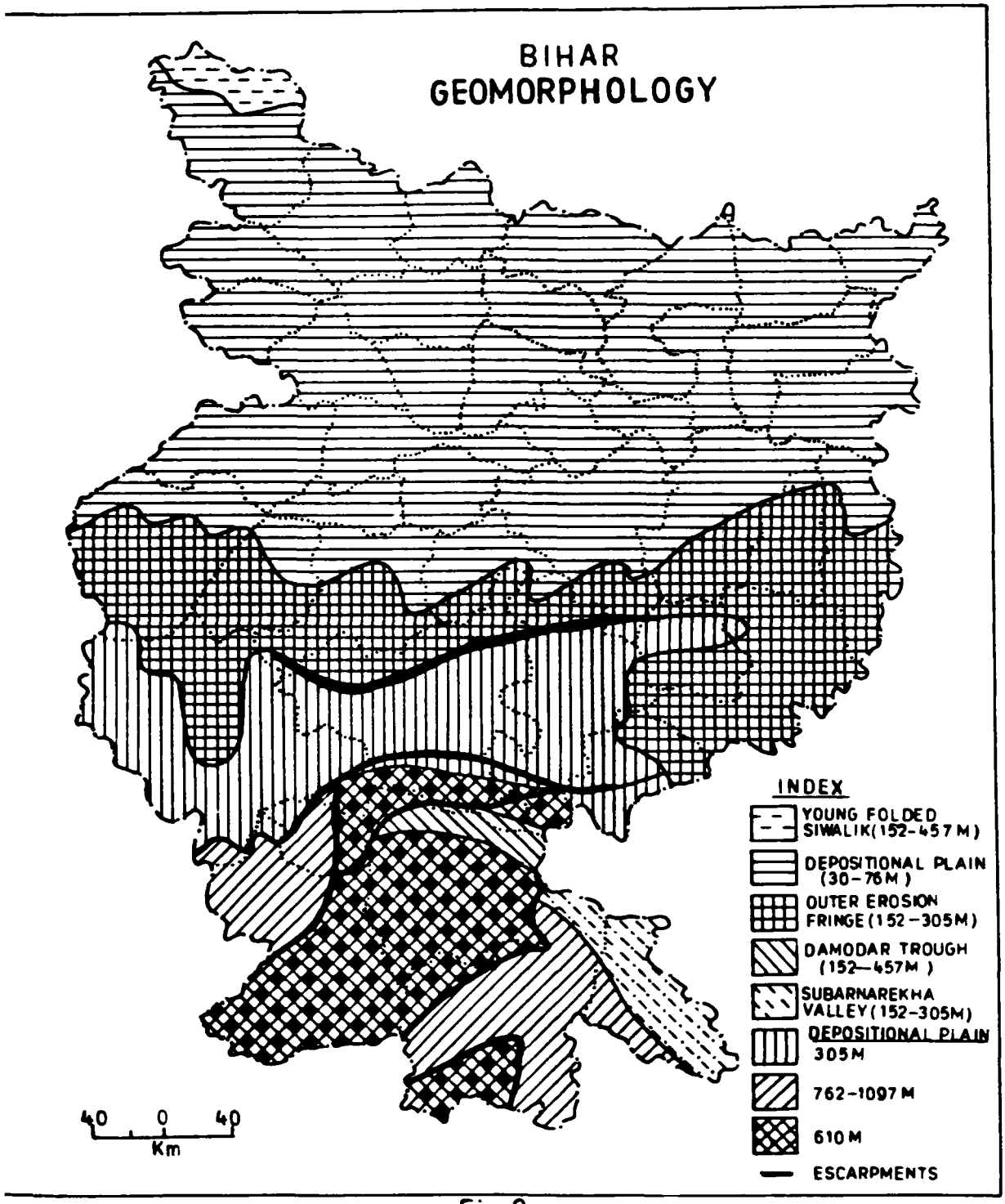

BIHAR
GEOMORPHOLOGY
INDEX
YOUNG FOLDED SIWALIK(152-457 M)
DEPOSITIONAL PLAIN (30-76 M)
OUTER EROSION FRINGE (152-305 M)
DAMODAR TROUGH (152-457 M)
SUBARNAREKHA VALLEY (152-305 M)
DEPOSITIONAL PLAIN
305 M
762-1097 M
610 M
ESCARPMENTS
40 0 40
Km

Fig. 3

have been broken into an area of very rugged relief consisting of a maze of ravines and ridges.

2. The Ganga Plain

The second major relief unit of Bihar is the Ganga plain which covers about 45080 sq. kilometres or 42 percent area of the state .It is roughly delimited in the south by the contour line of 152 metres above the sea level. The entire tract north of Ganga is absolutely alluvial and monotonously flat without a single hill appearing above the plain. South of the river Ganga, however, in what is known as South Bihar there rise in some places above the level of the plain low, small , isolated or long narrow hills as the Barabar hills of Gaya or Kharagpur hills in Munger. They are outliers of the Chotanagpur plateau. There are some differences in the relief features of the north Bihar and south Bihar portions of the Ganga plain which maybe noted below:

North Bihar Ganga Plain

The area is almost a dead level alluvial plain. The only diversities seen on the surface are those due to river action - a series of raised river side uplands known as levees and alternating depressions between the streams. From the north -western to the south-eastern corner of north Bihar plain the slope is roughly 30 metres in 400 kilometres. The North Bihar plain is below 75 metres above the sea level except small tracts in West champaran and North Saran. The rest of the plain drops imperceptibly to a height of 60 metres along the Ganga in the west and to 60 metres in the east.

Broadly speaking , the topography of the North Bihar plain consists of the following features: (a) A narrow moist *tarai* belt in West champaran district below the foothills formed by the re-emergence of the water that is soaked underground in the upper foothill gravel zone. The true *tarai* belt which is essentially a submontane phenomenon passes into Nepal east of West champaran district as the hills recede from the border of Bihar and is generally not found in the rest of North Bihar plain. (b) A sub *tarai* belt of marshy land in the north with intervening tracts of uplands along rivers. (c) This is succeeded in the south by a wide belt of marshy low lands notably devoid of uplands. (d) Further south nearer the Ganga the land rises and there is preponderance of uplands with a few intervening depressions and lakes.

South Bihar Ganga Plain

This plain is irregularly defined in the south because of the approach of the southern hills and plateau. It gradually tapers from a wide base in the west to a narrow tongue on the Rajmahal hills. The surface rises more rapidly away from the Ganga in this plain than on the north of the river. It has largely been built of the alluvium brought from the southern hills. This plain is roughly divisible into:

(i) a narrow belt of highland along the Ganga and.

(ii) The rest of the plain. In this second part behind the Ganga levee is a treeless low lying country called "*Tal*" lying in Patna district.

As we more towards south outliers of ancient crystalline rocks

appear as low hills i.e. the small hill near Bihar Sharief know as Pirhari (110 metres). There are higher hills at Rajgir (445 metres) which extend rather continuously towards Gaya. The rather extensive triangular hill of Kharagpur in Munger rises from 150 metres to 350 metres and its northern suballuvial projection is responsible for sharp bend of Ganga near Munger district. The Ganga plain of Bihar is the superficial expression of a thick body of alluvium which has been gradually accumulating in the vast depression limited in the north by the Himalayas and in the south by the Chotanagpur plateau and its outliers. The floor of the depression is asymmetrical being deepest nearer the Himalayas and thence becoming gradually shallow towards the south.

3. The Southern Hilly Region

This southern hilly region is known as Chotanagpur plateau. It consists of a series of plateaus. Each plateau occurs at a height different from that of adjoining plateau. There are four plateaus or in other words erosion surface in the region. The highest surface is formed by the higher Ranchi Plateau or "*pat*" region 760 metres to 920 metres above the sea level. It covers the north -western corner of Ranchi and the southern edge of Palamu district. It is believed to be composed of Deccan lava; but as a result of weathering the lava has been converted into laterite and bauxite. The second or the next lower plateau is known as Ranchi plateau and roughly covers the whole Ranchi district except the area covered by the "*Pat*" region. This plateau composed mostly of gneisses and granites' is about 600 metres above sea level. Ignoring minor variations the Ranchi plateau characteristically lies at an elevation

of 600 metres above sea level. The Ranchi plateau is separated from, an other surface of same elevation by Damodar trough. It is the upper Hazaribagh plateau and is probably a continuation of Ranchi plateau.

The third plateau has an elevation of 300 metres above the sea level and may be termed as the Outer or Lower Chotanagpur plateau. It consists of mostly gneisses and granites; but partly of Schists and other Dharwar rocks. This plateau covers a wide area on outer parts of Chotanagpur.

The next lower or the fourth erosion level is uniform surface formed by the river valleys; plains and lower parts of the outer low plateau lying between 150 and 300 metres above sea level. They again consists of gneisses and granites and partly of schists etc. The basaltic Rajmahal hills and the sand stone Kaimur plateau belongs to this erosion level. The different plateau surfaces in Chotanagpur are parts of same plain successively uplifted during Tertiary and pleistocene times.

DRAINAGE

As regards surface drainage of Bihar all surface drainage of the state except the districts of East Singhbhum; West singhbhum and most of Ranchi district i.e. about 18000 sq. kilometres ultimately goes to the Ganga or its distributary, the Hoogly. The area of about 18000 sq kilometres on West singhbhum ; East singhbhum and Ranchi is directly drained to the Bay of Bengal through Sankh, South Koel and

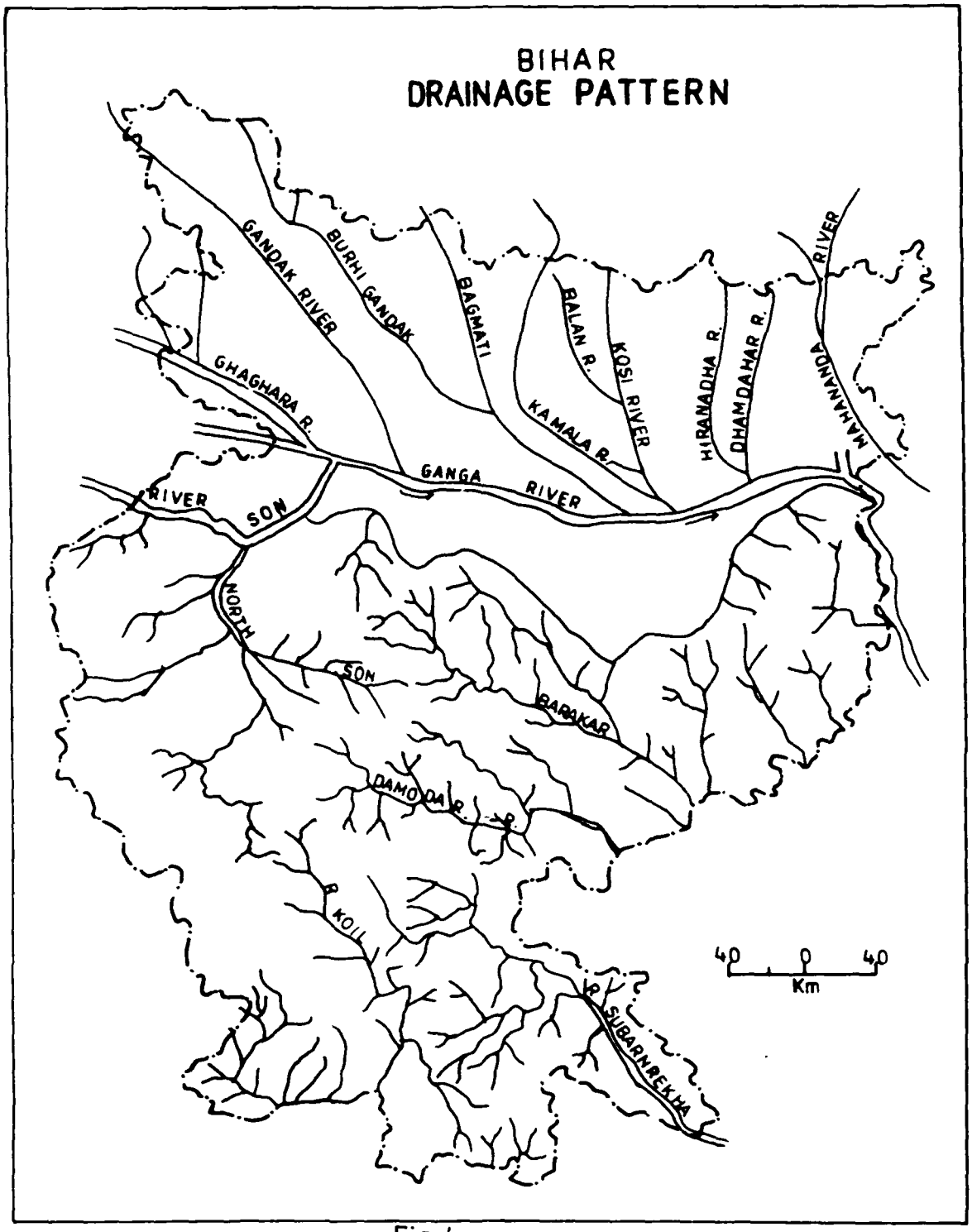

BIHAR
DRAINAGE PATTERN
GANDAK RIVER
BURHI GANDAK
BAGMATI
BALAN R.
KOSI RIVER
HIRANADHA R.
DHAMDAHAR R.
MAHANANDA RIVER
GHAGHARA R.
KAMALA R.
GANGA RIVER
RIVER SON
NORTH SON
BARAKAR
DAMODAR R.
R. KOEL
R. SUBARNREKHA
40 0 40
Km

Fig. 4

Subarnarekha rivers.

Comparison between the Streams of Chotanagpur plateau and North Ganga plain :

The Ganga is the master line of drainage in Bihar. The drainage coming from Himalaya through North Bihar plain and that coming from Chotanagpur is ultimately discharged into Ganga. The northern and southern drainage; tributary to Ganga ; however; has some points of comparison; but many of contrast. In the Himalayan fringe in West Champaran and East Champaran the northern tributaries of Ganga display the characteristics of young river rushing through deep and narrow gorges i.e. the Gandak at Bhainsalotan. They debounch into the plains through a series of rapids. The plateau streams display similar characteristics when they descend the scarped margins of Chotanagpur and Kaimur uplands and other hilly region of South Bihar. These southern streams pass through steep sided, narrow, rocky valleys or gorges in which they form beautiful rapids and waterfalls.

Below the Himalyan foot hills the northern streams flow through tortuous meandering courses in broad shallow channels which have been raised by large quantity of the sediments above the adjoining interfluves or *doabs*. The southern streams too have very tortuous courses in the plateau section and as they descend the scarps they meander in the South Bihar plains in shallow wide beds. But there are many differences between two types of streams resulting from physical differences of the area which they drain. The northern streams flow over a region of thick alluvium and there are no structural differences

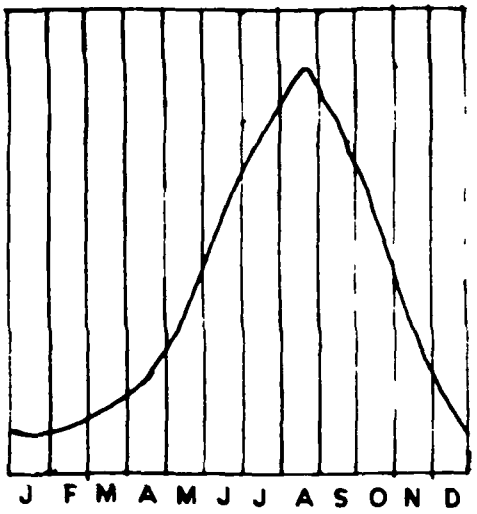
from one end of plain to the other. The plateau streams traverse regions consisting of rocks of different hardness. The northern streams are of very low gradient while the plateau streams have relatively steep slopes and are characterised by rapid flow in hilly region so that floods are common in the plains and they are unknown in Chotanagpur. The larger northern streams have wide low level riverine tracts on either side but plateau streams have deep clearly defined channels with a very narrow ribbon of alluvial margins.

One of the most important differences between the northern and southern streams is that of regime i.e. the volume of water flow during the course of the year as shown in Fig.5.

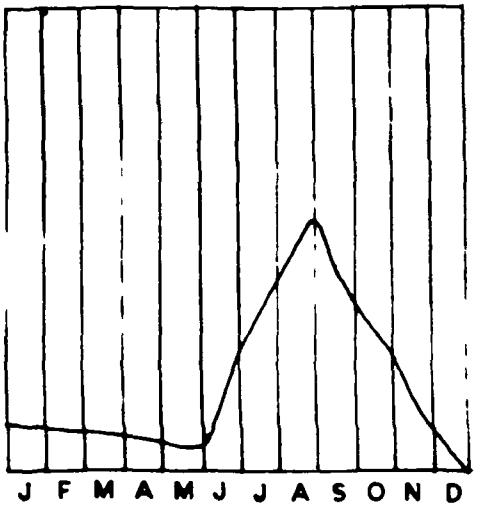
The larger Himalayan streams rise in the vast snow fields of the great Himalaya and are thus fed by snow melt in spring and summer months and monsoon and rainfall at other times. The plateau streams depend entirely on rainfall. From the plateau surface rain water rapidly flows out and there is limited soakage. Moreover, the largely impervious crystalline rocks of the plateau region also stand in the way of underground storage. Thus while the streams passing through plains particularly in North Bihar receive some water in their channel from seepage of underground water, such supply is very limited so far as the plateau streams are concerned.

The regime of the snow fed rivers i.e. the Ganga, the Ghaghara, the Gandak and the Kosi is characterised by a considerable discharge during the winter season falling to a minimum in the months of March and April, after which the melting of the snow in the Himalayas gradually

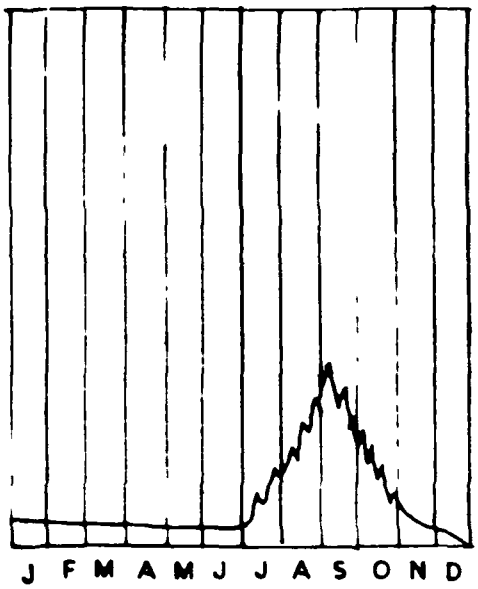
RIVER REGIMES(Approx)



(Snow Fed Himalayan Streams)



(Plain Streams)



(Plateau Streams)

FIG 5

raises the volume till it is complemented by the monsoon showers when the rivers rise in spate during late June, July and September.

The plateau streams on the other hand are ephemeral in character. They become disconnected pools of stagnant water during the cold and hot seasons, but immediately after monsoonal showers in the hills they come down in sudden short lived freshets. But the roaring cascade of water lasts only for a few hours, the streams subsiding again to fordability. Even during the monsoon the plateau streams donot maintain a regular flow which is of a very freakish nature, particularly on the marked slopes of the plateau where the run off is too quick to allow the streams to have a regular flow. When, however, the plateau streams have approached the Ganga, because of the presence of underground water the streams are characterised by a regular flow and larger discharge.

The drainage of Bihar is uneven in the sense that some parts are overdrained (i.e. water runs off too rapidly to allow the formation of extensive surface water bodies and to permit considerable soaking of water underground), some underdrained (i.e. the extensive surface bodies of water and water logging in conjunction with high water table) and others are well drained. Both the plateau streams when they come down to the plain and the northern streams along with Ganga itself are liable to changing its courses. They tend to raise and silt up their beds by the large amount of sediments carried during the rains. In course of time the rivers begin to flow in raised channels which lie above the surrounding region. During floods the pressure of large volume of

water causes a breach in the banks and the rivers may adopt a new course and so on the process continues. Apart from such vigorous changes alluvial and delluvial action is a regular feature, especially of the Ganga and its northern tributaries, causing minor and local changes in the river courses. The plateau streams are steeper and the diversion of their water for irrigation in South Bihar reduces the chances of changes in the river courses. But there has been considerable changes in the courses of Ganga, Son, Ghaghara, and the Gandak and immense changes in the courses of notoriously vagrant Kosi which appears to have once joined Brahmputra. Now it flows through Saharsa district and joins Ganga in Khagaria district. Broadly speaking, the common drainage pattern in Bihar is dendritic i.e. like a tree. The homogeneous, new and soft Ganga alluvium with a more or less flat topography favours dendritic drainage pattern.

Underground Water

The underground water resources of the Ganga plain region are markedly different from those of Chotanagpur and adjoining hilly areas. The hilly region is an overdrained area. As the rainfalls it is quickly drained off because of considerable slopes. Few permanent water bodies are found on the surface that might by soakage, contribute to the underground reservoir. Moreover, soakage and storage by underground rocks is also checked by the impervious and crystalline rocks that predominate in the hilly south. The underground waste reservoirs in Chotanagpur, Kaimur plateau and Rajmahal Hills is limited. The level of underground water table is uncertain and deep on uplands.

The underground water resources are so limited that even deep wells, particularly in upland areas go dry during summer so that the scarcity of water in this season is as acute as in arid areas. In forested region where evaporation is limited by shade, the water table may be high.

Flood

The physical nature of Chotanagpur makes the region immune from floods, but certain area in the plain frequently suffer from devastating floods during rains. The areas which are more frequently liable to serious floods lie north-east of Burhi Gandak river in North Bihar. Other areas of the plain especially those north of the Ganga suffer from occasional inundation.

CLIMATE

The climate of the state is similar to that of the North Indian Plains and is marked by three distinct seasons in a year. These seasons are: firstly a rainy season (mid June to mid October) corresponding to *Kharif* agricultural season with clouded sky, high humidity and heavy rainfall, a cold weather season (November to mid March) corresponding to agricultural season known as *Ravi* and characterised by low temperatures, clear skies, little rainfall and low humidity and thirdly a hot weather season (mid March to mid June) corresponding to agricultural reason known as *Zaid* characterised by high temperatures very low humidity and prevalence of hot dusty winds.

Season of General Rain

The normal date of the onset of the south-west monsoon in Bihar is from 7 June in the north-east and east, to about 15 June in the western end of the state. Once the initial monsoonal showers have fallen the surface become moist in Bihar in July and August and on subsequent days even in the absence of fresh monsoon from sea, intense insolation by day causes the ascent of local moist winds and clouds and rains follow. This is what is called rain from old monsoon.

The south-west monsoons normally withdraw from Bihar in the first week of October. It is known as retreating monsoon. An important feature of the season of retreating monsoon is the tropical cyclones which originate in the Bay of Bengal about 12° N latitude and invade Bihar.

Distribution of Annual Rainfall

The distribution of annual rainfall in Bihar varies from over 1905 mm near the north -eastern corner of the state to a minimum of about 1016 mm on the western border along the Ganga axis. Most of the North Bihar has more than 1270 mm as also the Chotanagpur region. The area of lowest rainfall is a triangle with apex in south Palamu, on the Ganga near Colgong and where river Gandak touches the border of Saran district. In this triangle rainfall decreases from 1270 mm on the south-eastern and north-eastern side to about 1016 mm towards the western base of triangle. The rainfall gradually decreases both towards the west and towards the Ganga.

The higher rain towards north-east is partly due to the Nor'wester rainfall in pre-monsoon period and partly due to the relief effect of the adjoining Himalayas. The relative dryness of the region on either side of the Ganga is due to the distance of the region from Himalayas on one hand and the Chotanagpur plateau on the other. The higher rain in the submontane Bihar is partly due to condensation resulting from ascent over the Himalayas. The Chotanagpur uplands have higher rainfall than the adjoining northern and north-western plain because they are nearer to the source of the monsoon depression. They are benefited by rainfall both from Bay of Bengal and Arabian sea branches. They have a higher elevation and rain must occur by simple fact that as the winds cross the plateau they have to ascend a height of 300-900 meters and are cooled adiabatically that causes cloud formation and consequently rainfall take place. The distribution of rainfall is given in Table 1.

Table 1

Distribution of Rainfall in Bihar

District	Average No. of rainy days	Normal Rainfall	Actual Rainfall
1. Patna	61.2	993.8	1153.2
2. Nalanda	54.2	990.0	1247.0
3. Bhojpur	51.4	1077.5	1132.2
4. Rohtas	51.6	1143.8	967.6
5. Gaya	55.5	1130.8	928.9
6. Jehanabad	60.3	990.5	1150.4
7. Nawada	55.5	1047.5	1216.9
8. Aurangabad	49.1	1236.7	940.4
9. Saran	49.8	1093.3	1282.3
10. Siwan	56.7	1071.8	1400.7
11. Gopalganj	51.0	1182.4	1302.1
12. Muzaffarpur	57.2	1180.9	1388.1
13. Champaran East	48.5	1356.5	1255.5

14. Champaran West	63.1	1410.6	1559.5
15. Sitamarhi	52.6	1266.8	1212.7
16. Vaishali	56.5	1042.3	1236.4
17. Darbhanga	56.6	1204.2	1208.9
18. Madhubani	55.8	1307.3	1354.2
19. Samastipur	51.3	1168.6	1399.1
20. Begusarai	68.0	1184.2	1640.9
21. Bhagalpur	68.0	1184.2	1640.9
22. Munger	65.9	1206.7	1193.2
23. Khagaria	62.6	1186.6	1210.3
24. Dumka	62.0	1160.0	1190.3
25. Godda	N.A.	N.A.	N.A.
26. Deoghar	N.A.	N.A.	N.A.
27. Sahibganj	N.A.	N.A.	N.A.
28. Saharsa	69.5	1385.4	1626.4
29. Madhepura	61.1	1367.5	1449.0
30. Purnia	75.9	1681.0	2215.1
31. Katihar	76.1	1358.0	1598.1
32. Hazaribagh	74.6	1284.5	1327.5
33. Giridih	77.5	1211.8	1604.8
34. Dhanbad	86.1	1310.6	1712.9
35. Ranchi	82.5	1454.1	1482.6
36. Lohardaga	63.8	1471.3	1115.5
37. Gumla	68.1	1543.8	1390
38. Palamu	63.5	1335.1	1068.3
39.Singhbhum East	78.5	1334.6	1500.3
40. Singhbhum West	75.3	1330.2	1490.2
41. Kishanganj	75.3	1630.2	2145.1
42. Araria	74.1	1590.6	2260.4

Source:- Regional Meteorological Centre, Patna, 1990.

Cold Weather Season

Bihar enjoys a cold season, the major part of the State being north of the Tropic of Cancer and southern portion being an elevated plateau. By the beginning of November all vestiges of monsoon except high humidity and marked dew by night have disappeared from Bihar. The wind throughout the season is mostly slight and is predominantly north-west and west. These winds are fed by downward settling of the air over north-western India caused by low temperatures and high pressure. In January the mean temperature ranges from 15.5. °C in the

north to 18.3 °C in the southern part of the state.

Both the Ganga plain and Chotanagpur fall along the paths of western disturbances arriving in this season all the way from Mediterranean area. These shallow, extensive, temperate cyclone bring cloud, rain and cold winds particularly in January and February and are immensely important for the *Rabi* crops of the plain. The rainfall of this season is almost uniformly distributed in the whole state and is about 25.4 to 127 mm.

Hot Weather Season

The hot weather begins in March. It is a period of continuously rising temperature and falling pressure. There is a feeble anticyclones covering the Bay of Bengal. The surface wind is north-west in the plains and west in the plateau. With the rise of temperature humidity falls. In April and May the sun has advanced further north and temperature is high. The mean temperature in May ranges from about 29.4 °C in the east and north-east of the state to about 32.2 °C in the west. Bihar as the rest of Northern India, experiences storms during hot weather season. These storms may be classified as dust storms, thunder storms and dust raising winds. These storms retards the temperature and bring relief to people for short duration from scorching heat. A very hot and dry wind known as *loo* is soil as also experienced in the month of May and June in northern India including Bihar plain. Its temperature invariably ranges between 40 °C and 50 °C. It may cause sunstroke to people.

SOILS

The soils of Bihar may be grouped into seven broad categories:

(1) Swampy Soils
(2) The Ganga Alluvium
(3) Calcareous Soils
(4) Red and Yellow Soils
(5) Red Sandy Soils
(6) Black Clayey Soils
(7) Laterite Soil.

Swampy Soils

The distribution of these soils have been shown in Fig. 6. These soils are found in the narrow belt of *Tarai* in the north of West Champaran district in the Siwalik region. In the extreme northern margin of this district a thin narrow belt of heterogeneous Himalayan soil is also found above the swampy soils. Swampy soil tract is conditioned by excessive moisture due to large amount of annual rainfall and continuous seepage of water from the northern sloping land. These soils remain saturated during the monsoon months and remain fairly moist during the succeeding winter owing to the presence of a high level of underground water. The soil is mostly clay to dark grey colour. Being clayey in nature. These soils are highly relentive of moisture, and are therefore most suitable for the cultivation of rice.

The Ganga Alluvium

The Ganga alluvium covers a vast area along the banks of the rivers Ganga, Gandak and Kosi. The soils of this group are generally light textured, light grey in colour and moderately alkaline in reaction

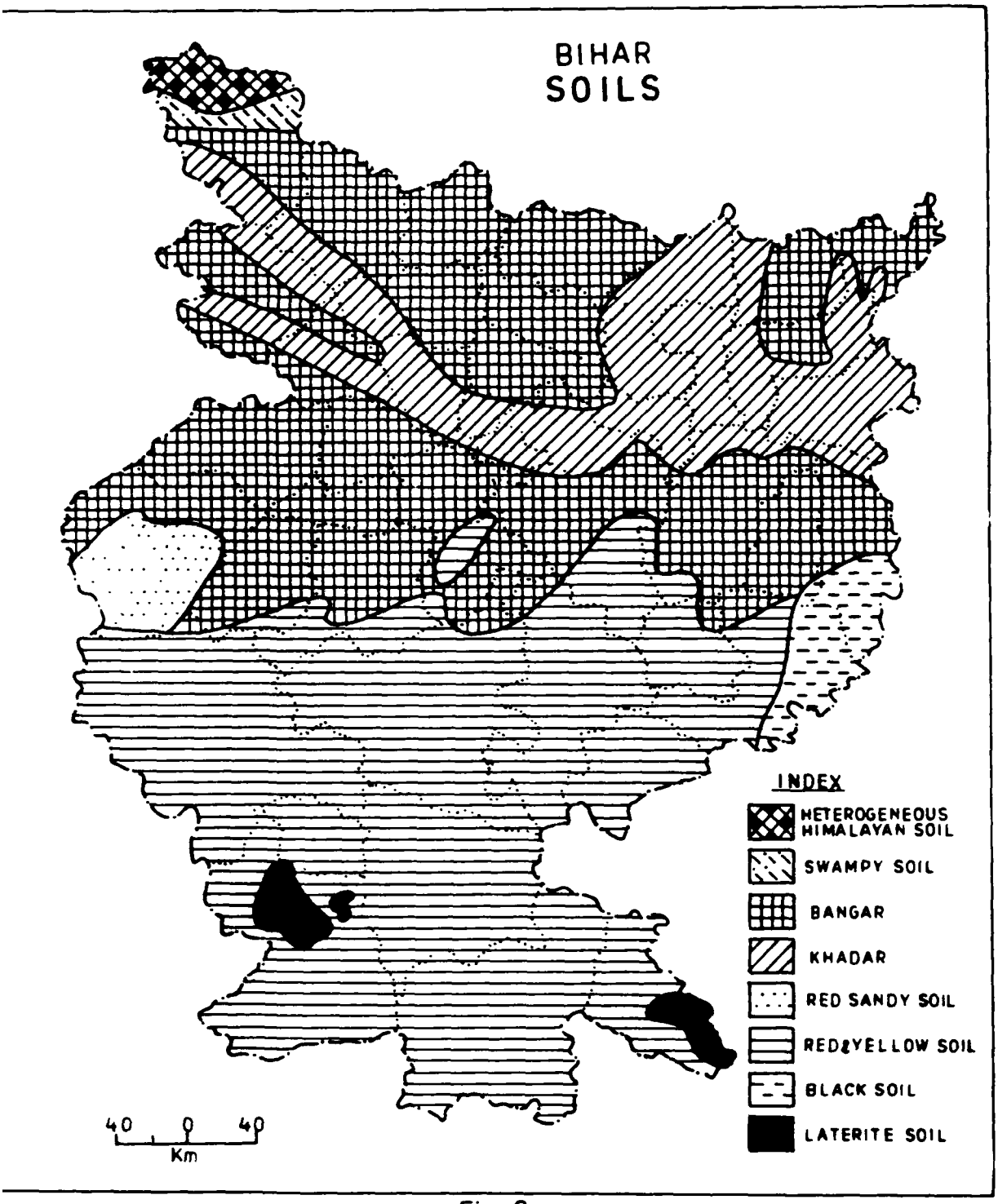

BIHAR
SOILS
INDEX
HETEROGENEOUS HIMALAYAN SOIL
SWAMPY SOIL
BANGAR
KHADAR
RED SANDY SOIL
RED&YELLOW SOIL
BLACK SOIL
LATERITE SOIL
40 0 40
Km

Fig. 6

with medium to high fertility status. The alluvium is mostly loamy in texture although sand and clay proportions vary from place to place. Variations in the fertility of soils from place to place, especially in the east where the rainfall is heaviest, are not so much due to differences in the surface soil but may be due to varying capacity of moisture retention.

The Ganga alluvium can be divided into two types:

(i) Newer Alluvium or *Khadar*

(ii) Older Alluvium or *Bhangar*

(i) Newer Alluvium or *Khadar* : is different from older alluvium or *bhangar* in texture and chemical composition. Soils comprising the newer alluviums are grey to ash grey in colour, and clay loam to clay in texture. It is generally found along the banks of rivers and streams. It is generally highly leached and is low in hums and nitrogen and poor in lime. Newer alluvium is found along the river Gandak in the districts of West Champaran, East Champaran, Muzaffarpur, Vaishali and in a narrow belt along the river Ghaghara in Chhapra district. It is more developed in the Kosi region. This soil is suitable for the cultivation surgarcane, paddy and root crops.

(ii) Older Alluvium or *Bhangar* : is found some distance away from main rivers. It is heavier soil with greater clay proportion than the *Khadar*. The *bhangar* of North Bihar plain generally lies between the higher levels of streams in lowlying interfluves and is inundated by water during the rains through spill channels which cut through the

levees. *Bhangar* land forms typical paddy areas of north Bihar plain. It is richer in lime than the *Khadar*. This group of soil occupies a vast area of West and East Champaran, Sitamarhi, Madhubani, Darbhanga and Purnia districts. It is also found in Muzaffarupur, northern parts of Bhagalpur, Munger and in a small patch of Begusarai districts.

Calcareous Soil

The belt of this soil roughly corresponds with the *Bhangar* area in Saran, the *Bhangar Doab* between the Little Gandak and the Baghmati in Muzaffarpur and occupies the tract of newer alluvium south of Little Gandak in West Champaran and East Champaran and a small tract in Western Darbhanga. In this zone the soil is lime accumulating and contains a remarkably high percentage of carbonate of lime in sharp contrast with the soils in adjacent districts which are almost devoid of lime. The beds of *Kankar* or nodular lime stone are a common occurrence in the subsoil. The probable causes of conspicuous lime proportion seem to be poor subsoil drainage owing to impermeable strata below and lower rainfall than the adjoining areas.

Red and Yellow Soils

Excepting a narrow belt of Gondwana sand stones and shales in Damodar valley the entire area is composed of crystalline and metamorphic socks, mostly granite and gneiss, while a large part of the Singhbhum district is occupied by the Schistose rocks which also constitute the Kharagpur plateau and hills of South Munger and adjoining areas. Many of these gneisses and schists are highly ferriginous, the

soils derived from them are deep red and even black in colour. Archaean system results in corresponding differences in the soils derived from them, but the soil as a whole is light with a relatively high sand proportion. There are great variations in consistency, depth and fertility.

Alkaline salts are often deposited for want of subsoil drainage. Laterite is found on higher levels in certain localities i.e. in East Singhbhum, West Singhbhum, South Bhagalpur and on the *'Pat'* surface. The clayey vesicular soil devoid of most plant constituents is infertile and is often given to *arhar* and castor, etc.

Black Clayey Soil

This residual soil is comparable to *regur*, the chernozem of India, and has developed on basic rocks on the western flanks of the Rajmahal Hills and the basic gneisses in Sahibganj, Godda, Dumka and Deoghar. It is a black clay which is hard when dry but friable. It is a sticky when wet and retains moisture for a long time. Owing to its relatively high fertility it may not require manure for a considerable time. Terrain plays an important part in the nature and thickness of the soil. It is infertile, thin and of light colour on the uplands, but on the lowlands and in valleys it is fairly deep enriched by washing from above and is given to paddy cultivation.

Dark Reddish Brown Soil or Laterite Soil

There are three distinct tracts of laterite soils in the state, one in Rajmahal Hilly area, in the other in south-eastern Dalbhum on Tertiary sediments and the third in the *'Pat'* region of the West Ranchi and

South Palamu. The typical red colour is due to high percentage of iron oxides. The area of Rajmahal Hills which are composed of Jurrassic traps are covered with laterite. The chief defect of laterite soil is its marked acid reaction. With the removal of acidity it can be rendered productive.

REFERENCES

1. Ahmad, E., *A Physical, Economic and Regional Geography of Bihar*, Ranchi, 1965.
2. O' malley, L.S.S., *Bengal district Gazetteer:* Sikkim (Calcutta, 1917).
3. Spate, O.H.K., *India and Pakistan*, (London, 1979).
4. O' malley, L.S.S., *Bengal District Gazetteer*, Purnia (Calcutta, 1911).
5. Ahmad, E., *Howangho of Bihar, Aligarh Magazine*, Aligarh Muslim University, 1946-49.
6. Pandey, M.S., *The Historical Geography and Topography of Bihar*, Patna, 1963.
7. Pandey, S., *The Rainy Season in Bihar, Geog. Rev. of India*, 23, No.1, 1961.

CHAPTER 2

CONCEPT OF AGRICULTURAL PRODUCTIVITY AND ITS MEASUREMENTS

Productivity is a measurement of production, or output in terms of the inputs required to operate the productive process[1]. Productivity is not a synonym of fertility. It is generally used to express the power of agriculture in a particular region to produce crops without regard to whether that power is due to the bounty of nature or to the efforts of man.

Productivity like disparity is a relative concept. The term productivity has been used in different meanings and has aroused many conflicting interpretations. Sometimes it is considered as the overall efficiency with which a production system work, while others it is defined as a ratio of output to input in relation to land, labour, capital and overall resources employed in agriculture. In reality, production refers to the volume of output while productivity signifies the output in relation to resources expended. Production can be increased by employing more resources without increasing productivity. On the other hand productivity can be increased without increasing production by employing less inputs for the same production level. But it is commonly agreed that productivity is the ability of a production system to produce more economically and efficiently. Therefore agricultural productivity can be defined as a measure of efficiency with which an agricultural

production system employs land, labour, capital and other resources.

In recent years many attempts have been made to define the connotation of agricultural productivity. Dewett (1966) explains it as, "productivity expresses the varying relationship between agricultural output and one of major inputs, like land or labour or capital, other complementary factors remaining the same.....". It may be borne in mind, that productivity is physical rather than a value concept.[2] The connotation of agricultural productivity engaged the attention of many an economist at the 23rd Annual Conference of the Indian Society of Agricultural Economics.[3] Some economists suggested that the yield per acre should be considered to indicate agricultural productivity. A number of objections were raised against this view because it considered only land which is just one factor of production while other factors are also responsible, and therefore, it was arbitrary to attribute productivity entirely to land and express it per acre of land. It was suggested, for instance, that productivity could also be measured in terms of per unit of labour and different regions compared on that basis. After a thorough discussion, it was generally agreed that the yield per acre may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible cause for the variation while comparing it with the other regions.[4] Pandit (1965) has expressed the connotation of productivity in these words: "Productivity is defined in economics as the output per unit of input..... the art of securing an increase in output from the same input or of getting the same output from a smaller

input.[5]" He further suggests that increases in productivity, whether in industry or agriculture, is generally the result of a more efficient use of some or all the factors of production, viz. land, labour and capital. Saxon incorporates the productivity as a physical relationship between output and the input which gives rise to that output.[6] Horring[7] considers productivity in broad terms, to denote the ratio of output to any or all associated inputs, in real term.

There are many different concepts of productivity, and still diverse ways for computing it. The Chairman of the International Commission on Agricultural Typology, Kostrowicki, invited different views on this problem by sending a questionnaire to over 100 scholars throughout the world, which embodied the following two questions:

1. What methods of measuring intensity of agriculture should be applied in typological studies of various orders?
2. What methods, measures and indices should be used to define land, labour and capital productivity of agriculture in topological studies of various orders?

About fifty geographers from all over the world responded and suggested various approaches to the measurement of agricultural intensity and productivity. The Chairman of Commission while evaluating the different views pointed out, that a special study for testing various methods and techniques to be used in the studies of various scales were needed.[8]

Land, labour and capital are various aspect of agricultural

productivity. These are the best known partial productivity measures. "Land" is viewed as area with different natural attributes. It realizes different rents and varies in purchase price. 'Labour represents all human services other than decision making and 'capital', the non labour resources employed by one farmer.

It is due to the pressure of population that special attention is given to land productivity. It is the simplest but in some respects the most useful aspect of agricultural productivity. Maximum production from land can be achieved with available inputs of land measures that can fulfil the pressing demand of the day. Inevitably the inherent chemical and physical properties of the land vary spatially and impose varying limits on the agricultural use of the land, although actual use will be dependent upon technology, profit and cultural constraints.[9]

Land productivity is obviously of primary importance in countries with a high density of population. When land resources are limited the principal means of raising production to keep pace with the growth of population is by rasing yields per hectare. However, raising the productivity of land does not mean only rasing the yields of individual crops. It encompasses the whole output of a farm or country in relation to the total area of farm land, and may be raised also by changing the pattern of production toward more intensive systems of cultivation toward higher value crops.

A distinction must be made between the measurement of agricultural output in terms of calories (or some other measurement of food values), and in terms of money values. For example, if in temperate

countries land is shifted from cereals to potatoes the output per hectare in terms of calories of human food is likely to be increased. But its productivity in terms of money values may be changed up or down according to relative prices of cereals and potatoes. Again, sihifting land from the main crop potatoes to the early season potatoes or to the luxury vegetables may well increase its productivity in money terms, but will almost certainly reduce it in terms of calories. Good pasture land used for grazing will usually produce less in calories for human food than if cropped with cereals for direct consumption, but may well show higher productivity in money values.

The productivity of labour is a somewhat more complex aspect than land productivity. Labour productivity means the income of the population engaged in agriculture and can be measured in terms of output per worker. It takes into account all the labour which contribute to agricultural production, the labour that is used directly on the farm as well as that used indirectly off the farm in producing the materials and services used on agricultural production.[9] The labour input may be expressed as the total number in the labour force or, in order to take into account the intensity of labour, as the number of man-hours worked in agriculture. Similarly the total agricultural output may be taken as the gross farm output or it may be taken as the value added by labour and other factors in the agricultural sector; i.e. the value of fertilizers, pesticides, fuels and other inputs from outside the agricultural sector, is substracted from the value of the output in order to determine the net contribution of the agricultural sector.[10]

Labour productivity is in fact the most common form of measurement and is usually implied in economic discussions when no specific definition is given. In so far as the output per man is one of the major determinants of the general level of economic welfare, labour productivity is a significant yard stick of economic progress. Various measurements of labour productivity may have specific uses in policy formation, e.g. with regard to income distribution, occupational distribution of labour force etc.[11]

Increases in the productivity of land and of labour often go hand in hand. When crop yields are increased or the pattern intensified there is usually, although not always, an increase in output per man. Similarly when improved methods are adopted to increase efficiency and raise labour productivity and farm incomes, there is often, as a secondary result, an increase in land productivity and total output. In countries with agricultural surplus this problems may be embarrassing, and increased labour productivity may then have to go hand in hand with measures to limit the area under cultivation.

Capital productivity of agriculture is particularly complicated to compute and difficult to interpret. This is largely because of diversity of capital being utilized in agricultural production: for land purchased for improvement, reclamation, drainage, irrigation, farm buildings, mechanical power, machinery and implements, livestock, seeds, fertilizers, crop protection chemicals etc. The presence or absence, amount, quality and price of each factor of production varies spatially, affecting the relationships between them and their deployment on

individual farms. These spatial patterns are not static, labour and capital being geographically mobile. The use of each production factor will not depend solely upon its availability. It will be influenced by technological, economic and social circumstances which permit the substitution of one for another and in turn will be affected by their degree of visibility.

Estimates of capital productivity give relatively little guidance in ensuring the most efficient use of the limited capital resources. In part this is because the statistics on capital in agriculture are less informative than those on land and labour, not because much of this investment stemming from the unpaid labour of the farmers themselves. The terracing of slopes, the bunding of paddy fields, the construction of irrigation ditches are examples of this type of non monetized investment which is of crucial importance for raising both output and productivity. This does not mean, of course, that capital is not of vital importance to agriculture. The requirements of fixed capital stock in agriculture even excluding land often appear to be greater in relation to the output than those of manufacturing industries and mining, though there are considerable differences between countries in methods of estimation.

The productivity of livestock is again more difficult to measure than the productivity of land. The difficulty arises both in the measurement of the input and the output. Much of the livestock production results in more than one end product: cattle may produce milk, beef and hides, sheep may produce wool and meat etc. A comparison of, say, the milk output of specialized dairy cows with

that of dual purpose animals kept for both milk and beef may be misleading. To aggregate the output of all livestock products, with suitable price weights, solves part of the problem but not all of it, because of the widespread use of livestock, particularly in the less developed regions, for draft power. A complete accounting of the output would, therefore, also require the inclusion of the draft power produced by livestock. The principal input is the capital represented by the livestock itself. Other inputs include the feeding stuffs which they consume, whether from grazing or in the form of preserved or concentrated feeds, and the land which is pasture or cropland is devoted to livestock production.[12]

The above measurement when combined shall not give a very satisfactory indication of productivity. The simplest and most frequently used comparison is the output of milk or meat per animal, which would be significant when cattle are of about the same size or weight. But if in one country the common breeds of livestock are large and in another small, differences between the average output per animal in the two countries will in part reflect these differences in size rather than their relative efficiency. And since small cattle eat less and since more small cattle can be kept on a given area, the total output of meat or milk per unit of feed or per hectare of land may be as high in one country as in the other. It could not then be said that the average productivity of the larger breeds was greater than that of the smaller breeds.[13]

The whole output from each hectare of land used for agriculture

in known as the overall productivity of land. It is more significant than crop yields per hectare or livestock yields. The individual yields reflect only the efficiency of crop husbandry or livestock husbandry, the overall productivity also take into account the managerial skill with which the various farm enterprises are integrated to increase the total farm output. The overall productivity reflects also the opportunities to produce high value crops i.e. tobacco, or in suitable climates or under irrigation to raise more than one crop per year from the same land. Thus, the countries with the highest total output per hectare appear to have an overall productivity some 40 times greater than those with the least intensive agriculture.[14]

The Measurement of Agricultural Productivity

The assessment of agricultural productivity has engaged the attention of scholars working in different disciplines like geography, economics and agricultural sciences for a long time. Many attempts have been made to measure and quantify agricultural productivity in India as well as in other countries of the world.[15]

The measurement of agricultural productivity is not a simple task as it involves a relationship between inputs and outputs in agricultural production. Input itself is a complex thing which governs farming efficiency. Stamp while attempting to measure crop productivity per unit area emphasized that areal differences in crop productivity are the result partly of natural advantages of soil and climate and partly of farming efficiency.[16] Farming efficiency refers to

the properties and qualities of various inputs, the manner in which they are combined and utilized for production and effective market demands for the output.

There is a substantial literature relating to methodological procedures for measuring productivity in agriculture.[17] The measures of agricultural productivity which are most frequently used are those of partial productivity and refer to the relation of a single input or a group of inputs to the total output or to a part thereof (yield per hectare, output per man hour, output per unit of capital). The data required to measure the productivity of a single input are more likely to be available than those required for measures of overall productivity. Besides, the aggregate of total inputs may tend to obscure the effect of changes in their composition. Owing to the multitudinous utility, experts of agricultural geography have developed techniques, suitable for measurement of agricultural productivity and efficiency.

Thompson[18](1926) while measuring the relative productivity of British and Danish farming emphasized and expressed it in terms of gross output of crops and livestock. He considered seven parameters. They are: (i) the yield per acre of crops (ii) the livestock per 100 acres, (iii) the gross production or output per 100 acres, (iv) the proportion of arable land, (v) the number of persons employed, (vi) the cost of production expressed in terms of wages and labour costs, rent or interest, and (vii) Prices relative profitability and general economic conditions.

Ganguly[19](1938) in his study of the Ganges Valley presented a theoretical discussion for computing productivity in agriculture. Firstly, he took into account the area under any crop 'A' in a particular unit area belonging to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. Secondly, Ganguly tried to obtain the index number of yield. This is found by dividing the yield per hectare for the entire region as the standard. This yield may be expressed as a percentage and the percentage may be regarded as the index number of yield. Thirdly, the proportion of the area under 'A' and the corresponding index number of yield were multiplied. There are two advantages which are apparent by using this method, i.e. (a) the relative importance of crop 'A' in that unit of study is assessed as indicated by the proportion of the cropped area which is under 'A', and (b) the yield of crop 'A' in comparison to the regional standard. The product thus obtained indicates actually an index of the contribution of crop 'A' to the productivity of the unit considered.

Kendall[20](1939), taking the acre yield of ten leading crops in each of the forty eight administrative counties in England for four selected years, tried on four coefficients: Productivity, ranking, money value and starch equivalent or energy. Of the four coefficients, the ranking coefficient is probably the easiest to calculate and gives a reasonable ranking of counties in order of productivity. To obtain the ranking coefficient, Kendall ranked each of the ten crops in the forty eight countries in order of their yield, then the sum of the ranks occupied by the unit was divided by the number of the crops

considered to obtain the average rank of the unit. Kendall's money value coefficient was based on the value of crop production of each county (which was obtained by multiplying the volume of production of a particular crop by price) and the results of ten crops for each county were added together and the total was divided by the total acreage in the county under the crops. Kendall's energy coefficient is based on the total energy value of various arable crops expressed as starch after the proportions assignable to by-products and the energy index was constructed by ascertaining the production of energy per acre under crops on the basis of a prepared table showing the energy value of various crops.

Kendall's money value coefficient poses one major difficulty, that data for certain crops are not available, for example, there are many vegetables and beans which are grown mostly for the consumption on the farms and their price data are not recorded in contrast to cereal crops whose data are adequate. While determining the money value coefficient, another difficulty arises with regard to the prices, for example, the prices prevailing in the region or in the country as a whole, in addition to the local variations in prices which depend on circumstances like proximity to the market or the relative nutritive character of the product. Significant differences in prices per tonne between the crops affect the final result heavily in favour of the higher priced commodity. In this method, the crop production of each unit area is valued by multiplying the volume of production of a particular crop by the price, and then add the results for selected

number of crops together. The total is divided by the total acreage in the unit area under the total selected crops. The result gives for each unit area a figure of money value per acre/hectare under the crops considered. So far as energy coefficient is concerned, an index based on nutritional factor ignores local variations because of the absence of data. Kendall, therefore suggests starch equivalent as the most suitable unit. While calculating a coefficient based on starch equivalent it should be decided: (a) whether a gross or net digestible energy figure is to be taken, (b) whether any allowance is to be made for by products, such as, wheat and barley straws or green stalks of maize, Jowar and bajra, and (c) whether any account should be taken of the fact that the energy in certain foods has first to be fed to livestock and then wheat and milk is used for human consumption. The basic question that arises in this technique is whether the gross starch equivalent of the various crops should be considered or the net equivalent. Net energy refers to the amount of energy for work and body building whereas, a gross figure includes the energy employed in the digestive process of consuming animal and similar non realisable forms. Kendall suggested that production of energy be preferred as the gross figures.

Hirsch[21](1943) has suggested 'Crop Yield Index' as the basis of productivity measurement. It expresses the average of the yields of various crops on a farm or in a locality relative to the yields of the same crops on another farm in a second locality. Zobel[22](1950) has attempted to determine the labour productivity. He considered the productivity of labour as the ratio of total output to the total man

hours consumed in the production of that output resulting in output per man hour. This has been expressed by the following equation:

π = f (P, L)

π = Productivity of labour

P = Productivity, and

L = Labour utilized

Huntington and Valkenburg[23](1952) considered land productivity on the basis of acre yields of eight crops raised very widely in Europe. For each crop, the average yield per acre for Europe as a whole was taken as an index of 100, and the specific yield in each country was calculated accordingly. Stamp[24](1952) adopted Kendall's ranking coefficient by selecting twenty countries and nine crops. The countries were placed in order of output per acre for each crop. The places occupied by each country in respect to the selected crops were then averaged, and from these averages, the ranking coefficient of agricultural efficiency of each country was obtained. If a country was a top of every list, it would have a ranking coefficient equal to the total number of countries concerned.

Another approach to measure productivity is to convert the total food production into calories. Quantitative food requirements are usually estimated in terms of heat units, calories.[25] A physiological calorie (also called kilo calorie and abbreviated (K cal) is the amount of heat necessary to raise the temperature of one kilogram of water by one degree centrigate. The caloric intake is a measure of the general health of a person because it determines the amount of heat and energy

needed by the human body

Stamp[26](1958) has taken calorific value of farm production in measuring the agricultural productivity. He calculated the Standard Nutrition Unit (SNU) by converting all the food production per acre in calories The British Medical Association has carried out an extensive enquiry based on all available sources and published a table to show the caloric intake among adults from 2100 a day for a women in sedentry occupation to 4250 for a man engaged in active manual work. For children the desirable intake is calculated at 800 a day for infants under one year to 3400 for teen age boy. The average of the different categories worked out at 2540 calories a day. Taking into consideration the age structure of the population, the range of occupation, the weight and height of the people living under the climatic conditions of North Western Europe, the average 2460 calories a day or about 900,000 calories per year. Making allowance for a loss of 10 percent in harvesting, cooking and food preparation the figure of 10,00,000 calories a year in terms of farm production may be accepted.[27]

The Nutrition Expert Group of Indian Council of Medical Research has recomended the daily allowance of Nutrients for Indians They published a table to show the caloric intake among adults from 1900 a day for a women in sedentry work to 3900 for a man engaged in heavy work. For children it was recommended 110 calories per kg weight of the body per day for infants under one year to 3000 for teenage boy [28]

Shafi[29](1960) has calculated this under Indian conditions in the twenty villages of Eastern Uttar Pradesh. The net caloric intake ranges

from 1828 a day (6,67,677 a year) to 2175 a day (795514 a year). According to him in no case it reaches the 9,00,000 calories postulated as the Standard Nutrition Unit. He concluded that in the well drained and irrigated villages of Eastern Uttar Pradesh the caloric intake per person amounts to about 2000 a day. Where the caloric intake drops below 2000 a day, both standard of living and standard of health are perceptibly lower.

Loomis and Barton[30](1961) have measured United States agricultural input and productivity in aggregate. To them, aggregate productivity depends upon conceptually consistent measures of agricultural output and input. The measures of inputs include all the production factors that depend directly on the decisions of farmers. Meiburg and Brandt[31](1962) have surveyed the earlier indices relating to the United States agricultural output, i.e., output estimates of total productivity. They consider eight indices of agricultural production which cover various phases of the period extending between the years 1866 and 1960. Makenzie[32](1962) has measured the efficiency of production in Canadian agriculture by using the coefficient of output relative to input. He mentions, that the concept of productivity measurement is difficult to define and even more difficult to quantify. Commen[33](1962) while working out the trends of productivity in agriculture of the state of Kerala (India) has measured productivity on the basis of yield per acre. Enyedi[34](1964) while describing geographical types of agriculture in Hungry used the following formula for determining agricultural productivity:

Y Yn T/Tn

where Y = total yield of the respective crop in the unit area,

Yn = total yield of the crop at the national level,

T = total cropped area of the unit

Tn = total cropped area at the national level.

Horring[35](1964) has suggested that the concept of productivity is based not only on the single relationships, i.e., differences in the same agricultural region or subregion as between successive periods (in time), and between similar agricultural regions in different countries or regions during the same period (in space). It may also be possible to make comparisons between the trends of productivity for different products, between different regions of national economy or between the agricultural regions and the national economy as a whole.

The Indian Society of Agricultural Economics, considered the problem and published a series of articles under the broad head 'Regional Variations in Agricultural Development and Productivity.[36] Among the contributors Chatterji and Maitreya[37](1964) have determined the levels of agricultural development and productivity during 1950-51 to 1957-58 in the state of West Bengal taking two crops (rice and jute) in consideration. They utilized the acre yield for this purpose. Dhondyal[38](1964) has measured variations in agricultural development and productivity by selecting three representative districts from the three regions of Uttar Pradesh, while assessing the role of credit, intensive crop enterprises, and the influence of irrigation water during 1962-63.

Garg[39](1964) worked out the trends in agricultural development with respected to total cropped area, gross irrigated area and food grain production in two districts of Uttar Pradesh, viz. Gorakhpur representing the Eastern region and Meerut from Western region and productivity by assessing acreage, production and average yield per acre of three important crops, viz. rice, wheat and sugarcane. This study extends from 1951-52 to 1960-61 covering the period between the first and second Five Year Plans. Gopal Krishnan and Ramkrishna[40](1964) have taken Andhra Pradesh (1) to measure the degree of variations with respect to (a) agricultural output per acre (Rs.), (b) output per head of agricultural production (Rs.), and (2) to account the causes of variations in each of the twenty districts of the state during 1959-60. The variables relating to the level of output per acre are selected as follows: (1) normal level of rainfall, (ii) percentage of current and old fallows, (iii) percentage of area under irrigation (iv) percentage of literacy, (v) percentage of population in agriculture, (vi) intensity of cropping, (vii) percentage of gross value other than foodgrains and fodder, (viii) the percentage of area under all crops excluding fodder and foodgrains, (ix) density of agricultural population per acre, and (x) percentage of total area under commercial crops including rice.

Sapre and Deshpande[41](1964) modified the Kendall's ranking coefficient by giving weightage to the area under different crops. The weights for ranks of various crops are proportional to the percentage of cropland under each crop. For example, an enumeration unit 'A' has rank 2 on the basis of wheat acre yield and occupies 30 percent of

the total cropped area, rank 3 on the basis of rice acre yield and occupies 25 percent of the total cropped area, rank 8 on the basis of gram acre yield and occupies 10 percent of the total cropped area. Thus the weighted average of the ranks would be: (2x30) + (3x25) + (8x10) = 215 divided by the sum of the weights as 215/65 = 3.3. According to Kendall's method it would have been 2+3+8 = 13 divided by the number of crops as 13/3 = 4.3.

The Indian Society of Agricultural Statistics, organised a symposium on the topic, 'Measurement of Agricultural Productivity' at the 17th Annual Conference of the society held at Jaipur in 1964. The research papers contributed by different scholars appeared in the Society's Journal, viz., *Journal of the Indian Society of Agricultural Statistics*, in the succeeding issue of 1965. Sarma[42] while defining the concept of agricultural productivity has suggested various parameters on which it can be measured. According to him, productivity can be considered in relation to land, labour and capital. It can also be considered in terms of overall resources employed in agriculture. In case of commodities like foodgrains, fruits and vegetables, sugarcane, and edible seeds, he suggests that the output of these commodities be converted into calories. While considering the other non food crops such as cotton and other fibres the only common measure being the value which involves the pricing of different product. For evaluating value of production farm harvest on wholesale prices have the definite significance. He also emphasized agricultural workforce as the basis of productivity measurement, e.g., the total number of labourer employed (in order to account the intensity of labour) or the number

of man hours worked in agriculture per unit of area.[43]

Khusro[44](1965) has linked assessment of productivity with the output per unit of a single input and output per unit of cost of all inputs in the agricultural production. Saran[45](1965) has applied Cobb-Douglas 'Production Function' approach for the measurement of productivity. The common purpose of this function is to express input output relationship between several inputs and one output in the agricultural systems. The function takes the following form:

$$Y = Ax^{b}_{1} x^{c}_{2} x^{d}_{3} x^{e}_{4} \ldots\ldots\ldots x_{n}^{y}$$

where x_1, x_2, x_3, x_4,....., x_n denote various inputs, like land, labour, capital assets, and other working expenses. The values of b, c, d, ...y represent elasticities of respective inputs. Tambad[46](1965) and (1970) has adopted 'Crop Yield Index' as the basis for measuring agricultural productivity. He explains that the purpose of this technique is to express the average yield of various crops on a farm or in a region relative to the yield of same crops on another form or in a second region. It can be expressed by the following equation:

$$\text{Crop Yield Index} = \frac{\Sigma^{n}_{i=1} Yi/Yio \,.Ai}{\Sigma^{n}_{i=1} .Ai}$$

where i = 1, 2, 3, ... n are the number of crops considered in an unit area or year,

Yi = is the weightage of crop i, denoted by the area under the crop as a percentage of total

cropped, and

Yio = is the average yield per acre of crop i, at the group of farms or entire region or the base year.

Shafi[47](1965) has assessed the productivity on the basis of labour population engaged in agriculture. According to him, it can be completed by dividing the gross production in an unit area by the number of man hours or less precisely by the numbers employed in agriculture. In order to assess the productivity on the basis of population engaged in agriculture it can either be obtained by dividing the total production with the number of workers, or a reverse index be applied where the total number of workers per unit of production is assessed.

Agarwal[48](1965) has adopted, 'Factorial Approach' while measuring agricultural efficiency in Baster district of Madhya Pradesh. In this approach a number of human controlled factors relating to agricultural production as : Crop superiority, crop commercialization, crop security, land use intensity and power input have been selected, excluding the environmental factors.

Buck[49](1937) assessed the agricultural progress in China by adopting the approach of 'Grain Equivalent' for this purpose he converted all the agricultural products into kilograms of grain equivalent in order to select as a unit of measure a kilogram, with whatever kind of grain was predominant in the region. A modification in this method

was attempted by Clark and Haswell[50](1967)by expressing the output in terms of kilograms of 'Wheat equivalent' per head of population

Dovering[51](1967) has measured the productivity of labour in the United States agriculture in aggregate since 1919 to 1954 as a whole, as well as commodity wise Bhatia[52](1967) while assessing the changes and trends in agricultural efficiency in Uttar Pradesh during 1953-1963 adopted Ganguli's method of productivity measurement and has devised an equation which would be read thus

(i) Iya = Yc/Yr 100

where Iya = is the yield index of crop a,

Yc = is the average acre yield of crop 'a' in the component unit, and

Yr = is the average acre yield of crop a in the entire region and

$$(ii)\ Ei = \frac{Iya\ Ca + Iyb\ Cb + \quad Iyn\ Cn}{Ca + Cb + \quad Cn}$$

where Ei = is the agricultural efficiency index

Iya, Iyb etc = are the indices of various crop and

Cd, Cb, etc = represent the proportion of cropland devoted to different crops

Shafi[53] (1967 and 1969) applied Stamp's 'Standard Nutrition Unit' technique for measuring the efficiency of agriculture in India He has considered the district as the areal unit, and has selected all the food crops grown in India Noort[54](1967) considered 'net total productivity' (being the relationship between the net product and factor input) as

the method for the measurement of field productivity and also to assess comparisons 'in time' or 'in space'. The purpose of this measure is to account changes in labour and capital inputs in agriculture.

Sinha[55](1968) has adopted a standard deviation formula to determine agricultural efficiency in India. In the study he selected all the twenty five major crops grown in the country which were grouped into creals, pulses, oil seeds and cash crops and specific yields per hectare of cereals, pulses and oil seeds were taken. In case of cash crop their monetary values were calculated (in Rs.) per hectare by incorporating wholesale market prices. Finally, the standard scores were computed and to give them weightage, these values were multiplied by the acreage figures, i.e., the ara of cultivation under the crops.

Shafi[56](1972) while measuring the agricultural productivity of the Great Indian Plains modified the Enyedi's formula. In the modified formula the summation of the total yield of all the crops in the district is divided by total area under the crops considered in the district and the position thus obtained is examined in relation to the total yield of all the crops considered at the national level divided by the total area under these crops. The formula would be read thus:

$$(Y^{w}/t + Y^{r}/t + Y^{mi}/t \ldots\ldots\ldots n) : (Y^{w}/T + Y^{r}/T + Y^{mi}/T \ldots\ldots\ldots n)$$

where $y_{w}, y_{r}, y_{mi} \ldots\ldots\ldots$ n = total yield of various crops in the district.

$Y_{w}, Y_{r}, Y_{mi} \ldots\ldots\ldots$ n = total yield of the respective crop at the

national level.

t = area planted under crop in the district,

T = area planted under the crop at the national level

Singh[57](1972) has attempted to measure the agricultural efficiency of Haryan in terms of nutrition units per unit area. He has tried to measure the carrying capacity per square mile in the area unit which can be expressed as:

$$Cp = Co/Sn$$

where Cp = carrying capacity

Co = Caloric output per square mile

Sn = Standard nutrition for ingestion in calories person/annum.

He expressed it as a percentage of the carrying capacity in the entire region to obtain index numbers, which give a measure of the agricultural efficiency of the areal unit relative to the entire region. The above may be expressed as:

$$Iae = Cpe/Cpr \times 100$$

where Iae = the index number of agricultural efficiency of an enumeration unit

Cpe = the carrying capacity in terms of population in the component enumeration unit,

Cpr = carrying capacity in the entire region.

The Indian Society of Agricultural Statistics in its 30th Annual Conference held at Bhubaneswar (Orissa) India, discussed some

aspects on agricultural productivity in the Indian context. Raheja, etal[59](1977) have measured the impact of high yielding varieties based on data collected under the scheme, 'Sample Surveys for Assessment of High Yielding Varieties Programme,' during 1973-74 and general variations in productivity on the basis of yield per hectare in India. Singh etal[60](1977) have accounted the level of increase in the yield of different crops during three decennial years i.e., 1950-51, 1960-61 and 1970-71 in each state of India, considering the relationship between the output of food grains and related inputs like, the application of fertilizer, proportion of area sown more than once and gross irrigated area.

Nangia etal[61](1977) conducted a field survey in the village Khandewala of Haryana state. The study takes into account the productivity levels at different fields of the village in terms of money value during 1974-75 and a number of factors enumerated in three broad categories, viz. environmental, technological and institutional which hold responsibilities for the productivity variations. Bhalla[62](1978) has considered output per person on constant average price for measuring productivity of labour in Indian agriculture in order to account for nineteen crops during triennium 1962-65 and 1970-73 for each district of India. Singh[63](1979) devised a method of presenting a two dimensional picture of agricultural productivity comprising two components viz., intensity and spread considering three variables (i) yield, (ii) grain equivalent, and (iii) cropping system in the districts of the State of Andhra Pradesh. Accordingly, a relative share of intensity

and spread for each micro unit (district) has been computed to the macro unit separately for the above three variables with the help of equation that have been derived.

REFERENCES

1. Johnston, R.J., *The Dictionary of Human Geography.*

   Basil Blackwell Publisher, Oxford, 1981.

2. K.K. Dewett and G. Singh, *Indian Economics*, Delhi, 1966, P.66.

3. Regional Variations in Agricultural Development and productivity, *Indian Journal of Agricultural Economics*, Vol.19, No.1, 1964, PP 168-266.

4 Summary of group discussions, Regional Variations in Agricultural Development and Productivity, *ibid*, PP. 263-266.

5. Pandit, A.D., Application of Productivity Concept to Indian Agriculture, *Productivity*, Special issue on agricultural productivity, 6, (2 and 3) 1965, P. 187.

6. Saxon, E.A., Special Concepts of productivity, *ibid*; 266.

7 Horring, J., Concept of productivity measurement on a National Scale, OECD, *Documentation in Food and Agriculture*, No.27, Paris, 1964, P.10.

8 Proceedings of the International Commission on Agricultural Typology (unpublished) Warsaw, 1966.

9. Morgan, W.B. and Munton, R.J.C. *Agricultural Geography*, London, 1971, P.54.

10. Folk Doverings, Productivity of Labour in Agricultural Production, *Agricultural Experimentation Bulletin*, 726 Urbana, University of Illinois, College of Agriculture, September 1967.

11. FAO, *The State of Food and Agriculture*, Rome 1963, P. 98.

12. Munir, A., *Agricultural Productivity and Regional Development*, Manak Publications New Delhi, 1992.

13. *Ibid*, P. 98.

14. *Ibid*, P. 108.

15. *Ibid*, P. 110.

16. Stamp, L.D., *Our Developing World*, London, 1960, P. 108.

17. Raising agricultural productivity in developing countries through technological improvement, *The State of Food and Agriculture*, FAO, 1968, Folk Dovering, Productivity of labour in agricultural production, *Agricultural Experimental Station Bulletin*, No. 726, Urban, University of Illinois College of Agriculture, September 1967; Durost, D.D., and Barton, G.T., Changing sources of farm output, *Production Research Report*, No.36, USDA, Agricultural Research Service, Washington, D.C. 1960; Horring, J., Concept of Productivity measurements in agriculture on a national scale, OECD, *Documentation in Food and Agriculture*, No.57, Paris 1964; Kendrick, J.W., Productivity

trends in the United States, *General Series*, No.71, Princeton, National Bureau of Economic Research, 1961; Loomis, R.A., and Barton, G.T., Productivity of Agriculture in the United States 1870-1958, *Technical Bulletin*, No.1238, USDA Agricultural Research Service, Washington, D.C., 1961, *The State of Food and Agriculture*, FAO, Rome, 1963, Hayami, Y. and Ruttan, V.W., Agricultural productivity differences among countries, *The American Economic Review*, Vol. 60, No.5, 1970; Shishido, T., Japanese Agriculture: Productivity Trend and Development of Technique, *Journal of Farm Economies*, Vol. 43, 1961; Vanden Noort, P.C., Agricultural Productivity in Western Europe, *Netherlands Journal of Agricultural Science*, Vol.15, No.2, 1967; Symposium on Measurement of Agricultural Productivity; *Journal of Indian Society of Agricultural Statistics*, Vol.17, No.2, 1965; Regional Variations in Agricultural Development and Productivity, *Indian Journal of Agricultural Economics;* Vol. 19, 1964; Productivity, Special Issue on Agricultural Productivity, *National Productivity Council Journal*, Vol.6, Nos.2 and 3, 1965; *The State of Food and Agriculture*, FAO, Rome, 1970.

18 Thompson, R.J., The Productivity of British and Danish Farming, *Journal of the Royal Statistical Society*, 89, Part II, 1926, P. 218.

19. Ganguli, B.N., *Trends of Agriculture and Population in Ganges Valley*, London, 1938, P. 93.

20. Kendall, M.G., The Geographical Distribution of Crop Productivity in England, *Journal of the Royal Statistical Society*, Vol.52, 1939, PP. 21- 48.

21. Hirsch, H.G., Crop Yield Index., *Journal of Farm Economics*, 25 (3), 1943, P. 583

22. Zobel, S.P., On the Measurement of Productivity of Labour, *Journal of American Statistical Society*, 45, 1950, P. 218.

23. Huntington and Valkenburg, *Europe*, New York, 1952, P. 102.

24. Stamp, L.D., The Measurement of Agricultural Efficiency with Special Reference to India, *Silver Jubilee Souvenir Volume*, Indian Geographical Society, 1952, PP. 177-78.

25. A recommendation was made by international organisations like FAO, WHO and the International Union of Nutritional Sciences that the Unit 'joule' should be used instead of calorie for expression of energy values. The new units Kilojoule (KJ) and Megajoule (MJ) may, therefore, eventually replace the Kilocalorie used now for expressing the energy value of food stuffs. The relationship between the two units is as follows.

    1 Kilo calorie = 4.184 Kilojoules (KJ) (Physiological Calories) or 4.184 joules. 1000 Kilo calories = 4.184 Mega joules (MJ)

26. Stamp, L.D., The Measurement of Land Resources, *The Geographical Review*, Vol. 48. No.1, 1958, P. 3.

27. Stamp. L.D., *Our Developing World*, London, 1960, P.110.

28 Gopalan, C., *Nutritive Value of Indian Foods*, Hyderabad, 1980, P. 9.

29. Shafi, M., *Land Utilization in Eastern Uttar Pradesh*, Aligarh, 1960, P. 222.

30. Loomis, R.A. and Barton, G.T., Productivity of Agriculture in the United States 1870-1958, *Technical Bulletin*, No.1238, USDA, Washington, D.C., 1961, P. 1.

31. Meiburg, C.O., and Brandt, K., Agricultural Productivity in the United States: 1870-1960, *Food Research Institute Studies*, 3 (2), 1962, P. 64.

32. Mackenzie, W., The Impact of Technological Change on the Efficiency of Production in Canadian Agriculture, *Canadian Journal of Agricultural Economics*, (1), 1962, P. 41.

33 Commen, M.A., Agricultural Productivity Trends in Kerala, *Agricultural Situation in India*, 17 (4), 1962, PP. 333-36

34. Enyedi, G.Y., Geographical Types of Agriculture, *Applied Geography in Hungary*, Budapest, 1964, P. 61.

35 Horring, J., *Concept of Productivity Measurement in Agriculture on a National Scale*, OECD, Documentation in Food and Agriculture, 57, Paris, 1964, P. 10.

36 *Indian Journal of Agricultural Economics*, 19 (1), 1964, PP. 168-266.

37 Chatterji, A. and Maitreya, P., Some Aspects of Regional

Variations in Agricultural Productivity and Development in West Bengal, *ibid*, PP. 207-12.

38. Dhondyal, S.P., Regional Variations in Agricultural Development and Productivity in the Eastern and Western Regions of Uttar Pradesh, *ibid*, PP. 193-97.

39. Garg, J.S., Variation Studies in the Agricultural Development and Productivity in Eastern and Western Regions of Uttar Pradesh, *ibid*, PP. 193-97.

40. Gopalkrishnan, M.D. and Rama Krishna, P.T., Regional Variations in Agricultural Productivity in Andhra Pradesh, *ibid*, PP. 236-37.

41. Sapre, S.G. and Deshpande, V.D., Inter-District Variations in Agricultural Efficiency in Maharashtra State, *ibid.*, P. 243.

42. Sharma, J.S., Measurement of Agricultural Productivity Concepts, Definitions, etc., *Journal of the Indian Society of Agricultural Statistics*, 27 (2), 1965, PP. 253-57.

43. *Ibid.*, P. 254.

44. Khusro, A.M., Measurement of Productivity at Macro and Micro level, *ibid*, P. 278.

45. Saran, R., Production Function Approach to the Measurement of Productivity in Agriculture, *ibid*, P. 268.

46. Tambad. S.B., Spatial and Temporal Variations in Agricultural Productivity in Mysore, *Indian Journal of Agricultural Economics*, 20, 1965, P. 41.

Tambad, S.B. and Patel, K.V., Crop Yield Index as a Measure of Productivity, *Economic and Political Weekly*, 5 (25), 1970, PP. 878-79.

47 Shafi, M., Approaches to the Measurement of Agricultural Efficiency, Unpublished *Proceedings of the Summer School in Geography held at Nainital*, Department of Geography, Aligarh Muslim University, Aligarh, 1965, P.4.

48. Agarwal. P.C., Measurement of Agricultural Efficiency in Bastar District: A Factorial Approach, *ibid.*

49. Buck, J.L., *Land Utilization in China*, I, Nanking, 1937.

50. Clark, C. and Haswell, M., *The Economics of Subsistence Agriculture*, London, 1967, PP. 51-52.

51. Dovering, F. Productivity of Labour in Agricultural Production, *Agricultural Experiment Station Bulletin*, No.726, College of Agriculture, Urban, Illinois, 1967.

52. Bhatia, S.S., Spatial Variations Changes and Trends in Agricultural Efficiency in Uttar Pradesh, 1953-63, *Indian Journal of Agricultural Economics*, 22 (1), 1967, PP. 66-80.

53 Shafi, M., Food production Efficiency and Nutrition in India, *The Geographer*, 14, 1967, PP.23-27.

54. Noort, P.C. Vanden, Agricultural Productivity in Western Europe, *Netherland Journal of Agricultural Science*, 15 (2), 1967, P. 166

55 Sinha, B N , Agricultural Efficiency in India, *The Geographer*, Special Number, XXI, IGC, 15, 1968

56 Shafi, M , Measurement of Agricultural Productivity of the Great Indian Plains, *The Geographer*, 19, (1), 1972, PP 7-9

57 Singh, J , A New Technique for Measuring Agricultural Efficiency in Haryana, *The Geographer* 19 (1), 1972, PP 14-33

58 Symposium on Regional Imbalances and Economic Development with Special Reference to Agriculture, *Journal of the Indian Society of Agricultural Statistics*, 29 (1), 1977, PP 109-24

59 Raheja, S , etal , Factors Contributing to Regional Variations in Productivity and Adoption of High Yielding Varieties of major Cereals in India, *ibid* , PP 112-13

60 Singh, D , etal , Crop Productivity Variation in India, *opcit*, PP 113-15

61 Nangia, S , etal , Variations in Field Productivity, A case Study of Khandewala, haryana, *Occasional Papers*, No 7 (Mimeo), Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, 1977

62 Bhalla, G S , Spatial Patterns of Agricultural Labour Productivity, *Yojana*, 22 (3), 1978, PP 9-11

63 Singh, V R , A Method for Analysing Agricultural Productivity, *Agriculture and Food Supply in Developing Countries*, (ed ,

J.T. Coppock), Published for the Commission on World Food Problems and Agricultural productivity of the IGU, Department of Geography, University of Edinburg, 1979, PP. 43-51.

CHAPTER 3

CONCEPT OF REGIONAL DEVELOPMENT AND ITS MEASUREMENTS

Development is a dynamic concept. It has different meanings for different people. In fact, there is no agreement on the meaning of development among planners and thinkers. Some people say it means increase in income, others lay emphasis on employment, quality of life an happiness. Still others give stress on meeting the basic needs of the people. The only thing on which every one agrees is that development is necessary; and every one wants, although in his own image and perhaps in his own way.

Development has been defined as "a process of growth, expansion or realization of potential; bringing regional resources into full productive use". In another words development is a process of change aiming at socio-economic transformation of a traditional societies into modern one which is greatly influence by human beings. Activities related to the development is generally directed towards national buildings and socio-economic transformation. Development planning has also been defined as "any action by the state whose purpose is to raise the rate of economic growth above that which would take place without any conscious effort". Development planning is being done by the state; it has the dual purpose of economic growth and social structural change; it is comprehensive, covering every sector.

region and aspect of life. The achievement of a state of development would enable individuals to make their own histories and geographies under conditions of their own choosing.

Regional research and regionalization are classic themes of geography. Ideas of spatial development development compose the core of the theoretical basis of geography. However, in the epoch of scientific and technological revolutions the very concepts of 'development' and 'space' undergo transformation, this being reflected in the changes of concepts in the sciences investigating these phenomena and process. The present chapter is an attempt to elucidate the concepts of 'development' and 'regional development' by tracing recent advancement in this field. Since 'development' occurs in different socio-economic settings and takes different forms at national and regional levels specific to historical and socio-economic circumstances prevailing there, therefore, a synoptic review of studies of regional development is also made in the last section of the chapter.

The Concept of Development

'Development' is a multidimensional process. There are, therefore, many interpretations of it. In geographical literature during the late 1970s and early 1980s, there have come certain works which attempt to define development. Notable examples include Brookfield's[1] (1975) Interdependent Development, Robert's[2] (1978), Cities of peasants, Mabogunje's[3] (1980), The Development process: a Spatial Perspective Chisholm's[4] (1982) Modern World Development. a

Geographical perspective and Harriss's (1982), Rural Development: Theories of peasant Economy and Agrarian change. Each presents its own, very different view of 'development' provides a particular perspective from which further research can take its course. Mabogunje has identified four main ways in which the term 'development' has been used: development as economic growth, as modernization, as distributional justice and as socio-economic transformation. He argues that for a long time following the Second World War development was seen simply as economic growth; it implied a rapid rise in productivity per capita, and a changed economic structure. Holder[6] (1968), thus concentrated on economic development in his book on the tropics, and Chisholm[7] (1982) has described development as "a term used to signify an evolution of the economic structure accompanying expansion in total output". Chisholm (1982), goes on to distinguish between 'development' and 'modernization', the latter being seen as the social transformation of a nation. For Mabogunje[9] (1980) this is the second way in which the word 'development' has been used. Development, still in the sense of economic growth, came to be seen as part of a much wider process of social change described as modernization. Lipton[10] (1977) has thus, for example seen "development as modernizing structural change". However, Mabogunje[11] (1980) also points out a crucial aspect of this view of 'development' as modernization is that "to be modern meant to endeavour to consume goods and services of the type usually manufactured in advanced industrial nations". He goes on to observe that more recently development has been identified with distributional justice: as a way

of reducing the poverty level among the masses or, as it was more succinctly put, satisfying their 'basic' needs (Mabogunje 1980)[12]. For this to be successful the concept of accessibility was crucial, and much attention was therefore paid to an analysis of the access of the poorest of the poor to 'resources' defined in the broadest of terms. In his last category of views of development, Mabogunje[13] (1980) suggests that "Scholars of a Marxist philosophical persuation argue that the questions of distribution and social justice can not be considered or resolved independently of the prevailing mechanisms governing production and distribution". This, Mabogunje argues, gave rise to dependency theory, in which development and under development are seen as being totally interrelated and also to an emphasis on three broad issues: the fact that development is human issue, its requirements of the full mobilization of society and the idea of development is human issue, its requirements of the full mobilization of society and the idea of development as a redefinition of a country's international relations. In this view Roberts[14] (1978) has advocated that "Development is an interdependent process in which some countries and regions acquire predominant place with in division of labour, using coercion to organize production elsewhere, as in case of colonialism or control of capital or advanced technology and market..... . This situation is expressed in two related concepts that of dependency and that of the core periphery relationship".

To these four basic concepts of 'development' Mabogunje[15] has added his own, a fifth, which sees "development process as one of

spatial organization. The reorganization arises as a result of the fact that development implies the articulation of a new set of social goals". While Mabogunje's classification provides a useful frame work for viewing the nature of work done on 'development' itself. For too long the concept of 'development' has inculcated a dangerous bias in the conceptual approach of academics and politicians alike.

In all the definitions of 'development' by Mabogunge there has remained a thread of the old economic definition: that development, to a greater or lesser extent, implies increased productivity, high levels of consumption per capita and a shift from primary to secondary and tertiary economic activities. 'Development' is normally equated simply with economic growth. Few studies attempt to grasp the more complex question of social change. The concentration of attention on economic development is no doubt partly due to its easier measurement: how indeed is social development to be measured? In addition to the attention paid to economic issues, there lies the implicit assumption that, in general development should take place along the lines of western countries. The use of the word 'development' tends to imply that there is a set of developed nations, normally identified with the Western nations astride the north Atlantic ocean, and a set of less developed, or under developed or developing, countries, which given the right set of condition, will in their turn be able to become developed. This, for example, is the implicit assumption behind Rostow's[16] (1978) sequence of stages of economic growth. Even the concept under development, which introduces the idea that the poorer countries of the world are

poor in some way because of the existence of rich ones and thus overcomes the problem associated with sequential concept of growth and maintains an underlying concern with economic issues. Historically, economic change has always been associated, sooner or later, with the degree of social change. With much recent research having been on economic change, there is perhaps now a need to re-evaluate the social impact of the economic change and, for those involved in implementing it, to redress the balance by planning for social rather than economic change. The experience of Green Revolution in India, a classic example of economic growth, was nevertheless associated with increased social inequality (Pearse, 1980)[17] and today remains a pertinent reminder of the need for an integrated approach to change. Similarly, Saudi Arabia's economic transformation is taking place in association with strict efforts to maintain the traditional social and religious structures unchanged. This separation of permitted economic change and forbidden social change is already leading to growing tensions within the kingdom and must remain a source for concern.

During the last two decades 'development studies' have become a far more interdisciplinary field of enquiry. Geographical approaches within this field have much to offer. Gould[18] (1982) thus argues that "in the area of rural-urban interaction geographers have, in the theories and techniques at their disposal and in their appreciation of the need for detailed data collection, a comparative advantage over other disciplines". Likewise Mabogunje, in conceptualizing development as spatial recognization, has continually emphasized the importance of a

geographical awareness in 'development'. Harriss and Harris[19] (1979) have, nevertheless, noted that there is a "dearth of studies exploring the connections between development and the imperatives of management of the biosphere".

'Development' is thus defined as a process of betterment for a large human group. It includes economic development as well as social transformation. The United Nations University Expert Group on Human and Social Development in November 1975 gave the meaning of 'development' as "Development is a fundamentally..... about, by and for human beings. Development must therefore begin by identifying human needs. The objective of development is to raise the level of living of the masses of the people and to provide all human beings with the opportunity to develop their potential". Thus the definition clarifies that the development implies not only expansion in quantitative terms but also structural changes in the society and its economy as expansion proceeds. Structural changes includes institutional, social and economic (sectoral as well as spatial) aspects. This implicit assumption behind the lumping together of all these aspects is that change in one element depends on and generates changes in all others. Secondly, development means change in a desired direction and at a desired speed. The direction and rates of change will depend upon the goals and objectives of development. Thirdly, development presupposes policy interventions direct or indirect in achieving the given goals and objectives. Fourthly, development also involves socio-psychological transformation of human beings to prepare them for the eventual as

well as current benefits occurring from the changing socio-economic structure of society; and finally development, development involves temporal, sectoral and spatial phasing and integration of planning.

The Concept of Regional Development

The notion of development in the context of regional development refers to a value positive concept which aims at enhancing the levels of the living of the people and general conditions of human welfare in a region. It is a value positive concept because development is not only a change but a change for better, just as plant develops into a tree and a child into an adult and there is no reversal of the position attained. Economic development is reflected through growth of output and national income. Thus an important indicator of economic development is the increase in per capita income. Development is neither class neutral nor it is uniformly available across the regions. The development process benefits some classes of the society more than other classes. It helps certain regions to attain higher levels of development than other regions. This gives rise to social disparities as well as regional disparities. Such a situation operates because of the behaviour of parameters of development.

Regional development has been interpreted as intra-regional development design to solve the problems of particular regions. The concept has a multidisciplinary approach. The first connotation of regional development is economic in which the difference in growth in terms of volume and structure of production, income, employment is

measured to know differences in the levels of development. This procedure is employed both for national as well as subnational areas.

The concept of regional development may further be viewed in connection with plan, policies and balanced development. The policies of regional development are aimed at reducing the regional disparities existing in a particular to minimum and to find out the possible means for developing the region as a whole. Economic planners have viewed regional development problems from sectoral angles, so that regional development has become synonymous with sectoral planning for a sub-national territory with the result that all the weakness of central planning have been introduced at the regional level keeping in view the lack of interest in spatial organization and development.

Balanced regional development does not mean equal development of all regions. It simply implies fullest development of the potentialities of an area according to its capacity so that the benefits of overall economic growth are shared by the inhabitants of all the regions. Balanced regional development does not mean self sufficiency in each region. Neither does it mean equal level of industrialization nor a uniform economic pattern for each region. This type of development is practically needed for the under developed countries like India to minimized backwash effects, to rapidly develop the economy smoothly, to develop and conserve resources, to maintain political stability defend the country, to over come social evils and to promote and secure larger employment opportunities. To find the success on these points balanced regional development has been an important policy objective

in India since the beginning of the planning era. This idea has been mooted as a corrective process to minimize the differences in the degree of economic and social development in the different parts of the country. Such differences are manifest in per capita income, employment pattern, standard of living, house hold expenditure, extent of saving, rate of capital formation, growth rate in productive sector, education and social progress.

At the micro level (villages and development blocks), the aim of regional development is generally conceived to minimize disparities in the level of development as observed in differential access to resources and differences in the economic structure and social transformation. These differences are generally found in the industrial structure, access to infrastructural facilities and to amenities. The purpose of the researcher is to measure differences in the general level of socio-economic development to find out differences between small areas and to suggest alternative distribution of facilities and amenities so that observed differences in access to resources are minimized. Furthermore, the researcher has to find out differences in the pace setting process as development of technology and modernization so that these process are strengthened in areas lagging behind. This will facilitate the full use of potentialities offered by a region.

Historically the concept of planning has had closer links with administration and politics than with social and economic factors. However, the concept of Regional planning has assumed greater importance in developing countries because it brings out the

development potentialities of each region, suggests strategies for development, considers both the human and material resources within each region, is comprehensive in nature and concentrates on inter-sectoral problems and area studies. Thus if handled properly, it has the potential to be an efficient tool to create a better environment for human beings. Christaller, Philbrick and Dickenson gave importance to both spatial and functional regions especially with respect to regional development.

Parameters of Development

Natural environment, technology and institutions are the three basic parameter of economic development. Natural environment indicates the direction of economic development. It simultaneously puts a limit on the extent of development (at the given level of technology). For example, the major economic activity has been agriculture in river valleys, lumbering in forested region and fishing in the coastal regions. Moreover, the extent of production levels in all these activities are limited by the level of technology available to the people in the respective regions. Technology is the tool with which the human beings interact with the natural environment, but technology has its own characteristics. Primitive technology is size neutral and is available to all irrespective of their income levels. Intermediary technology is size biased and is available only to those who have some investable surplus. Sophisticated and large scale technology is so costly that it has to be brought under social control, becomes available to all irrespective of their size after a nominal payment. Thus,

the intermediary technology creates income disparities with a social group and across the regions. The institutions have been created by human beings for accelerating the pace of economic development. But when these institutions become rigid, they become a cause of declaration rather than acceleration of the pace of economic development. That is why the institutions are modified or changed with the passage of time. Thus, the level of economic development is the function of the harmonious interaction between natural environment, technology and the institution created in a region.

Measurement of Regional Development

It has been seen earlier that measurement of levels of development is an essential stage in policy formulation and planning. Measurement is the assignment of numbers to the properties of empirical objects or events in such a way that one to one correspondence is maintained between the relations among the properties measured and the characteristics of the number assigned. Regional development can be, and is conceived of in many ways. Inherent in the very use of the term is some sense of significant variations in the way in which people produce and consume, work, live and play. To record and measure a vast mosaic of variation in the nation as a whole and in its various parts of regions is no simple undertaking and even the most sophisticated statistical tools can hardly do full justice to measure comprehensively all aspects of regional development, as the variables so vast and diverse in nature and some even escape the limit of quantification. However, a useful starting point is to make a distinction

between the variations that would seen to be associated with the volume of economic activities and social progress. The most commonly employed measure, really crude indicators of economic and social welfare-of improvement or decline in the average status of families and the individual are the relative levels of per capita income as it is assumed that economic health is invariably followed by social progress. However recently it has been argued that per capita income or any other measure of economic progress as levels of production and consumption are partial measures of development as these do not necessarily measure variations in the economic structure and least of social health. They touch only tangentially most of the essential elements of development. The analysis of regional development, therefore, poses the problem of measurement. In early seventies there has come up the social indicators approach. This approach points outs that development goes beyond some aggregate measure of levels of consumption and production of goods and services. This approach emphasizes that variables indicating social status should also be included when measuring levels of development. As such, there is no single criterion on which levels of development can be assessed. Therefore, an analysis of regional development proceeds with the selection of suitable indicators which measures not only differences in economic structure, and production, but also indicate variation in health, education, housing, leisure, social security and a number of other variables. However, their selection depends on the availability of statistics at appropriate unit of analysis.

Measurement of Regional Development in India

Recently there have been many studies of regional development in India and its parts. These are analysis of spatial variations resource endowment and of sharp contrasts in levels of development in different parts of the country. An attempt has been made to review some of these studies.

The foremost work is being done by Techno-Economic Surveys. These surveys examine the state's physical resources in their aggregate by a rapid technical and economic audit of the resources of the state and prepare and overall plan for development of states in a 10-15 years perspective in relation to desired growth rate of the economy of the state. The main drawback of such studies is the lack of integrated planning of resources of national importance since every state has been treated in isolation.

There are several other studies which have been conducted for specific purposes in which the emphasis is on the area and its problem in contrast with sectoral studies. The Central Arid Zone Research Institute (CAZRI) at Jodhpur has been studying the problems of semi arid Rajasthan and neighbouring areas. Various experiments and data compiled in respect to geomorphology, vegetation and climate provide valuable material for generalization over wide areas.

A regional approach to the study of urban problem is emphasized by the Town and Country Planning Organisation. Master Plans of large cities provide a wealth of information on the interrelationship of

the city with neighbouring areas.

In 1956, the Planning Commission at a conference on Regional Survey and planing (Delhi, 19-20, October, 1956) recognized that it would be necessary to conceive planning regions for the country at three levels: macro, meso and micro. Since then considerable work has been done and much thought has been given to 'planning region' by the geographers. Studies made by Learmonth (1964), Parkasha Rao (1962) and Bhat (1962) laid the groundwork for further studies. In 1962, the Regional Survey Unit prepared a tentative regional framework for resource development,[20] for the country based on an analysis and synthesis of various distribution pattern of resources physical complexes, cropping patterns and the distribution of urban centres, natural resources and major industries. In this study major regions and regional norms of development were described in quantitative terms. The guiding principle in this scheme was that major region should have minimum disparities and maximum distinctiveness from their neighbours in respect of their character and resources for development, further, Bhat[21](1964) suggested a scheme of seven macro economic regions based on the distribution of resources and possibilities of developing regional production complexes. He also considered another set of five macro-economic regions derived by grouping states together.

Based on work done by Indian Statistical Institute and earlier census regions, Nath prepared a scheme of resource development regions and divisions, which was published by planning commission in 1964[23]. In this scheme regions were demarcated on the basis of

topography, geological formations, soils, rainfall, agricultural landuse, cropping pattern, population density, and occurrence of mineral resources. The map prepared by Bhat[24] indicates the pattern of industrial development in the background of resource potential in different areas. Contiguous areas of urban industrial development occurring along the edge of the Krishna-Godavari Delta or from Coimbatore plateau to the Kerala Cost are the resultants of a relatively developed agricultural based industries. The patterns of levels of development as brought by mapping the index values seems to explain the causes in disparities in levels of development in an objective way. The study shows that the areas having low levels of development coincided roughly with those having low land productivity or lack of good resource base and occurrence of small and stagnant towns without much industrial activity and intertown relationship. On the other hand, Hyderabad occurs on an 'Island' of development in relatively under developed area of Telengana. Influence of Five Year Plans on the development have been analysed at some length by Learmonth with special reference to Mysore State[25].

The earliest study in the level of development was made by Schwartzberg[26] (1962). The use of a composite index of development brought out areal differences in levels of development, although these differences could not be further put rigorous regional analysis as the data were on the basis of states (Prior to 1956) which are not ideally suited to reveal regional differences.

[illegible] (65) put a more systematic attempt in the construction

of a composite index of selected variables which permit several stages of analysis in relation to the group of variables contributing to overall development; with a study of All India Level it may be regarded essentially as a contribution to methodology in areal differentiation by factor analysis. To be of use in policy decisions these studies need some of the important variables like per capita income and production which are directly related to the levels of development. Using some what different method Mitra[28] (1965) has grouped 324 districts of India into four levels of development. For this study he has selected 63 variables and these were grouped into six convenient blocks. The variables pertain to natural factors, agricultural infrastructure, traditional economy, human resources, organized industry etc. This study is unique for its simplicity and systematic approach. Nevertheless, the author himself pointed out in his introductory remarks that, the lack of more important indices and methods of giving weights to different variables is a limitation to this study. The data of per capita income is different to calculate below the state level. The National Council of Applied Economic Research has arrived at district level per capita income and the proportion of 'income' of each district according to primary, secondary and tertiary activities. These data, though crude, serve to relate the income pattern with land use structure and occupational patterns and urban-industrial development in broad regional analysis[29].

Sen Gupta and Sadasyuk have worked out the economic regionalization of India in an attempt to provide a hierarchy of regions useful in national planning[30]. A scheme of planning regions has been

started in the National Atlas Organization. The Planning Commission itself has brought out yet another scheme of 'Resource Development Regions and Divisions of India[31].

Nath[32] (1970) on the basis of state and district level data worked out the regional patterns of economic development and economic growth within India. Analysis of the level of economic development has been made for both states and districts, but analysis of growth rates has been made only for states. The level of economic development of states has been measured in two ways: (i) on the basis of per capita income, and (ii) through the use of a composite index of economic development based on four indicators. Analysis of economic growth has been made with the help of data on growth rates of population, agricultural output, per capita value added in industry, and per capita income. He mapped the states of India into two categories of relatively developed and less developed.

Prakash[33] (1977) assessed the regional inequalities and economic development in relation to infrastructural facilities in India. He selected several infrastructural factors: the various population characteristics that reflect the development of infrastructure determinants of industrialization, the development of power, irrigation and agricultural implements and road transportation, communication and banking services. He obtained two important conclusions from the analysis of development of individual regions in various fields: (i) there is no region which is equally developed or underdeveloped in all fields. For example, developed areas like TamilNadu, West Bengal, Andhra Pradesh,

Maharashtra, Kerala and Punjab are underdeveloped in one or most of the fields like literacy, workforce participation rates, per capita power consumption, irrigation or mechanization of agriculture while the underdeveloped regions like Jammu and Kashmir, Nagaland, Arunachal Pradesh are quite developed in one or more fields like literacy, density of population, workforce participation rates, urbanization, power consumption and road transportation. It would, therefore, be more useful for policy purposes to identify individual areas of deficiency rather than to bracket regions as developed or underdeveloped in general so that the remedial measures to make up the deficiencies could be evolved and implemented; (ii) the other important result is that the some region/regions come under the category of developed regions if one indicator is used, while they fall in the category of underdeveloped regions if some other indicator relating to the same field is used for classification. It implies that an appropriate indicator should be chosen to determine the stage of development of the regions.

Hemlata Rao[34] (1984) while studying the regional disparities, dimensions and typology of backwardness in Karnataka applied the technique of factor analysis in delineating the regions. The study covers 175 talukas (villages) of Karnataka and examines inter taluka diversities in the land utilization pattern, cropping pattern, agricultural development, patterns of industrial spread, and industrial developments, level of development of education, health, transport, communication, power, banking and cooperative sectors and overall development level during period between 1975-76 and 1979-80. The study concludes that in

Karnataka there is not only wide diversity in natural endowments but also wide disparities in the levels of sectoral and aggregate development. All backward regions are not the same, rather they have different dimensions and typology of backwardness. The causes of backwardness also vary from region to region.

The studies of regional patterns of development in India provide a conceptional and methodological framework to extend them to micro level with necessary modifications. The present study employs extensively concepts and methodology developed in these studies to analyse the patterns of regional development in the area under study.

REFERENCES

1. Brookfield, H., *Interdependent Development* Methuen, London, 1975.
2. Roberts, B.,*Cities of peasants: The Political Economy of Urbanization in the Third World,* Edward Arnold, London, 1978.
3. Mabogunje, A.L., *The Development Process: A Spatial Perspective*, Hutchinson University Library, London, 1980.
4. Chisholm, M., *Modern World Development; a Geographical Perspective*, Hutchinson University, London, 1980.
5. Harriss, J. (Ed.), *Rural Development: Theories of Peasant Economy and Agrarian Change*, Hutchinson University Library, London, 1982.

6. Hodder, B.W., *Economic Development in the Tropics*, Methuen, London, 1968.
7. Chisholm, M., *op. cit.*, P.14.
8. *ibid*, P.14.
9. Mabogunje, A.L. *op. cit.*, PP. 38.
10. Lipton, M., *Why poor people Stay Poor: Urban Bias in World Development*, Temple Smith, London, 1977.
11. Mabogunje, A.L. *op. cit.*, PP. 38-39.
12. *ibid.*, P. 39.
13. *ibid.*, P. 42.
14. Roberts, B. *op. cit.*, P.13.
15. Mabogunje A.L. *op. cit*, P. 49.
16. Rostow, W. W., *The World Economy: History and Prospect*, Macmillan, London, 1978.
17. Pearse, A., *Seeds of Plenty , Seeds of Want: Social and Economic Implications of The Green Revolution*, Clarendon Press, Oxford, 1980.
18. Gould, W.T.S., Rural - Urban Interaction in the Third World, *Area*, 14, P. 334.
19. Harris, J.J. and Harris, B., Development Studies, Prog. Hum. Geog., 3, P. 576.
20. Rao, V.L.S.P. and Bhat, L.S., A Regional Framework for Resource Development in India, *Bombay Geographical Magazine* Vol.10, No.1, 1963, PP. 35-50.
21. Bhat, L.S., Aspects of Regional Planning in India, *Liverpool Essays in Geography* London, 1964.

22. Idem, Regional Concepts and Planning Regions with Special Reference to Planning in India, in *Regional Planning* (ed.), R.P. Misra, Mysore, University of Mysore, 1969, PP. 73-86.

23. Planning Commission, Government of India Resource *Development Regions and Divisions of India*, New Delhi, 1964.

24. Spate, O.H.K. and Learmonth, A.T.A., *India and Pakistan*, London, 1967, PP. 331 -364.

25. Learmonth. A.T.A., Retrospect On Project in Applied Geography in Mysore State, India, in R.W. Steel and R.M. Prothero (eds.), *Geographers and the Tropics Liverpool Essays*, Liverpool, 1964, PP. 323 - 348.

26. Schwartzberg, J.E., Three approaches to the Mapping of Economic development in India *Annals of the Association of American Geographers*, Vol. 52, 1962, PP. 455 - 468.

27. Pal, M.N., Regional Disparities in the Level of Development in India, *Fifth Economic conference*, New Delhi, 1965.

28. Mitra, A., *Levels of Regional Development in India*, census of India, 1961, Vol. I, Part I - A (i), 1965.

29. National Council of Applied Economic Research, The District Income Differentials 1955-56, *Occasional Paper*, No.6, New Delhi, 1963.

30. Sen Gupta, P. and Sadasyuk, G., *Economic Regionalization of India: Problems and Approaches*, in A. Mitra (ed.), Census of India Monograph Series, Vol. I, No.8, New Delhi, 1961.

31 Government of India, Planning commission, *Resource Development Regions and Divisions of India*, New Delhi, 1965.

32. Nath, V., Levels of Economic Development and Rates of Economic Growth in India - A Regional Analysis, *The National Geographical Journal of India*, Vol.15, Part 3-4, 1970, PP. 183 - 198.

33. Prakash, S., Regional Inequalities and Economic Development with Special Reference to Infrastructural Facilities in India, *Indian Journal of Regional Science*, Vol. IX, No.2. 1977, PP. 172 - 195.

34. Rao, H., Regional Disparities Dimension and Typology of Backwardness and Strategy for Development, ICSSR *Research Abstract Quarterly*, Vol. 13, No.3 and 4, 1984, PP. 1-10.

CHAPTER 4

PATTERN OF AGRICULTURAL PRODUCTIVITY

Agricultural productivity is one of the components of regional development. It is a multidimensional concept which includes number of complex factors viz. environmental, technological and institutional. These factors affect the agricultural development of a region.

It may be pointed out that the agricultural development should be assessed by the agricultural production and productivity, and also by various physical inputs, extent of cultivated area, irrigation, fertilizers, improved seeds and labour availability. If assessed in this manner, agricultural development may constitute as one of the significant components of regional development. It provides increased food surplus to growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the population of the region.

The concept of integrated agricultural development means viewing agriculture not as a separate sector but rather as a branch of economy completely integrated into the development process and contributing to the fulfillment of the objectives which society as a whole has set for itself. It may be noted that agricultural surplus increases the rural incomes which tend to improve the quality of life of rural people. This surplus gives the chance to the villager to consume more nutritive food in the form of superior quality cereals, eggs, *ghee*

(refined butter), milk, fruits etc. They build better houses get vehicles and also receive the facilities such as irrigation, banking, transport, schools, health centres etc. Thus increased agricultural surplus plays a vital role in raising the standard of living of the overwhelming majority of the rural population of an area. In this context it is felt that the approaches which are preferable in the fields of agricultural productivity should be appropriately selected in the present study appropriately. The selected approaches should be sensitive enough to explain quite a sizeable proportion of the total variation in the agricultural productivity.

The regional variations in the pattern of agricultural productivity of Bihar have been assessed by applying two methods for measurement of agricultural productivity. A district has been selected as unit of the study. All the important crops[1] grown in the region have been considered for the computation of the productivity for the year, 1980-81 and 1990-91.

The following methods have been adopted for measuring the agricultural productivity for the area under study.

1. Agricultural Productivity: Based on Yang's Crop Yield Index

Yang's Crop Yield Index method considers yield of different crops selected in a district compared with the average crop yield in the entire region. The procedure for calculating the crop yield index for a district X is explained here. In the beginning, the average yield of each of the crops grown in the entire region is determined. Later on a

value is obtained by dividing the yield per hectare of a crop in district X by multiplying with 100 gives the index number as shown in col.5 of Table 2. By considering the area devoted to each crop as a weight and multiplying it with the percentage index, the products are obtained as listed in column 6 of Table 2. By adding the products of different crops and dividing the sum of products by the total area in the district X (the sum of col. 4), the average index obtained is the desired crop index for a particular unit using crop area as a weight.

Table 2

Method of Calculating Crop Yield Index[2] of the District X

Crops	Yield in Quintal per hectare		Area Under crop in the district X	Crop Yield in the district X as a %age of entire region (col.3/col.4x100)	Percentage multiplied by area under crop (col.5xcol.4)
	Average Yield in Entire Region	Yield in the district			
1	2	3	4	5	6
Rice	12.90	12.00	91648	93.02	8525096.6
Wheat	12.80	11.30	89573	88.28	7907504.4
Maize	6.50	11.80	45589	181.54	8276227.0
Barley	7.60	6.60	3456	86.84	300119.0
Total	-	-	**230266**	-	**25008947.0**

$$\text{Crop index for the district X} = \frac{\mathbf{25008947.0}}{\mathbf{230266}}$$

$$= 108 \text{ percent}$$

2. Agricultural Productivity: Based on Agricultural Output per Hectare of Cropland (Price Weighted)

This method of productivity measurement has certain advantages, because land is the most permanent and fixed among the other factors for evaluating productivity. Recently it has assumed a special attention due to population explosions and relative return from it. In order to evaluate productivity indices in each district farm level harvest prices for the corresponding years have been incorporated. This gives the agricultural output per hectare (in Rs.). These indices of a farm output have been computed by multiplying the harvest price to the production of the crop concerned. These products were finally added up and divided by the total crop area to get the value of output per hectare (in Rs.).

Agricultural Productivity Regions

A uniform technique of standard deviation (SD) is used in delineating the agricultural productivity regions. The computed values of productivity indices are given in Appendix B. On the basis of these productivity indices mean and standard deviation have been calculated for both the index as given in Table 3.

Table 3

Parameter of Agricultural Productivity Indices

	1980-81		1990-91	
	X_1	X_2	X_1	X_2
Mean	88.74	2040.21	92.01	5280.56
S.D.	19.91	342.63	23.42	905.89
C.V.	17.92	16.72	25.45	17.15

X_1 = Yang's Crop Yield Index

X_2 = Agricultural Output per Hectare (in Rs.)

S.D. = Standard Deviation

C.V. = Coefficient of Variation

Agricultural productivity regions are demarcated by plotting productivity indices of the districts in the map. Areas of high, medium and low productivity regions are demarcated with the help of a graded scale prepared by arranging all the indices of two points of time in a descending order and selecting five sets of very high. high, medium, low and very low values. The productivity regions thus obtained are shown with the help of maps.

Productivity Regions: Based on Yang's Crop Yield Index Method 1980-81

In the year 1980-81 Yang's Crop Yield Index varies in the region from 116.27 (Nalanda) to 54.96 (Palamu) (Appendix B). This variation

is further confirmed by a coefficient which is variation of 17.92%.

In the regional pattern two distinct small areas of very high agricultural productivity are found as shown in Fig 7, one lies in the north-western part of the state and includes the districts of, Champaran East (113.93), Champaran West (115.80) and Sitamarhi (104.27), the other which is consists of Nalanda (116.27), Patna (107.69) and Begusarai (106.77) form a compact block in the Central part of the state. There are three small areas of high productivity regions, ones lies in the northern part of the state including the districts of Vaishali (90.58) and Samastipur (100.83), the second lies in the north eastern part and includes the districts of Purnia (97.58) and Bhagalpur (96.50) and the third lies in the south-eastern part of the state which includes the districts of Giridih (100.57) and Dhanbad (90.63). Apart from this there are three scattered districts, which fall under the category of high agricultural productivity which are Siwan (94.95), Rohtas (90.13) and Ranchi (94.63). The area under very high and high productivity regions cover the 49 percent of the net sown area. Out of which only 16 percent area comes under very high agricultural productivity.

The areas of medium agricultural productivity grade form two contiguous regions in the north-western part of the state. It includes the districts of Bhojpur (80.50), Saran (87.42), Gopalganj (89.17), Muzaffarpur (85.07) and Darbhanga (88.17). Another contiguous region of medium productivity lies in the south-eastern part and it includes the districts of Hazaribagh (78.12), Nawada (84.62), Munger (78.50), Santhal Pargana (84.77) and Katihar (81.27). The area under medium

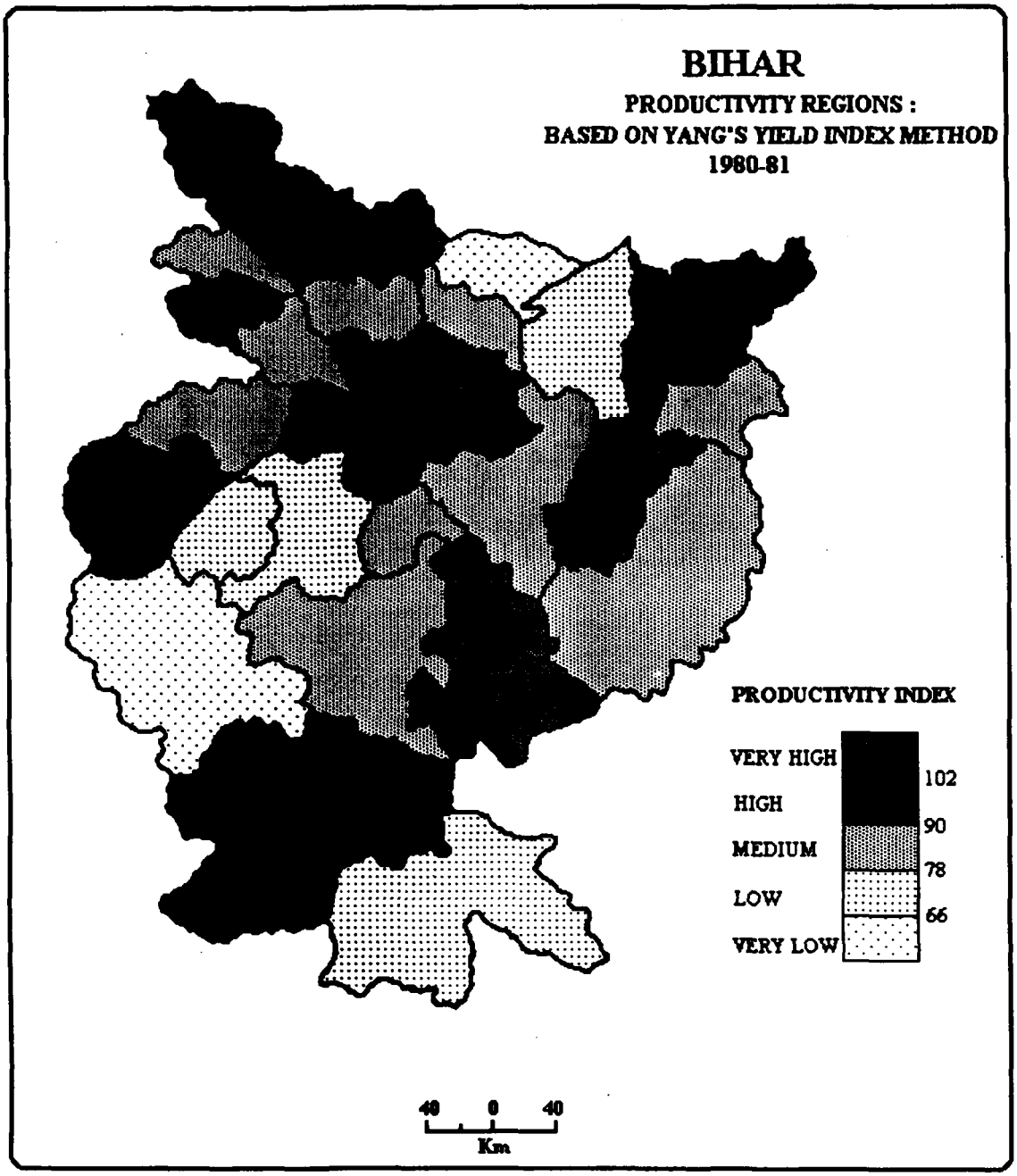

BIHAR
PRODUCTIVITY REGIONS :
BASED ON YANG'S YIELD INDEX METHOD
1980-81
PRODUCTIVITY INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
102
90
78
66
40 0 40
Km

FIG. 7

agricultural productivity covers a net sown area of 2527 thousand hectares which is 30 percent of the net sown area.

Out of four districts having low agricultural productivity, two districts form a small block in the south-central part of the state. It includes the districts of Aurangabad (76.00) and Gaya (77.43). Other two districts are scattered over other parts of the state are Saharsa (71.01) and Singhbhum (66.05). There are only two districts of very low agricultural productivity. They are Palamu (54.96) in the south-west and Madhubani (55.54) in the north. The low and very low agricultural productivity regions cover a net sown area of 1790 thousand hectares which is 21 percent of the net sown area. Productivity regions based on Yang's Yield Index has been shown in Fig.7.

Table 4

Bihar: Crop Yield Index

Grade	Index		Net sown area as% of Gross Cropped area		No. of Districts	
	1980-81	1990-91	1980-81	1990-91	1980-81	1990-91
V. High	Above 102	Above116	16	18	6	5
High	90-102	100-116	33	24	9	11
Medium	78-90	84-100	30	25	10	12
Low	66-78	68-84	16	20	4	10
V. Low	Below 66	Below 68	5	13	2	4
Total			**100**	**100**	**31**	**42**

(Based on Yang's formula)

Productivity Regions: Based on Yang's Crop Yield Index Method 1990-91

Yang's Crop Yield Index varies in the region from 135.27 (Nalanda) to 51.87 (Singhbhum East). Appendix C. This variation is also confirmed by the coefficient of variation, which is 25.45%. In the year 1980-81 it was only 17.92%.

The regional pattern shows that two small blocks of very high productivity regions are identified which is depicted in Fig.8; one lies in the central-eastern part and includes the districts of Rohtas (126.41) and Bhojpur (127.83); the other lies in the central part of the state which includes the districts of Nawada (130.49) and Nalanda (135.27). Champaran East (117.79) is the only other district which comes under this category of very high agricultural productivity, but do not form any region. As far as high agricultural productivity regions are concerned there are eleven districts which comes under this category. They form a large contiguous region which includes the districts of Champaran West (100.17), Gopalganj (112.98), Siwan (106.09), Saran (108.98), Patna (122.37), Vaishali (106.90), Samastipur (111.75), Begusarai (106.65), Khagaria (103.19), Jehanabad (111.25) and Gaya (101.90). The very high and high agricultural productivity regions covers net sown area of 315 thousand hectares which is 42 percent of net sown area, out of which 18 percent area is under very high agricultural productivity.

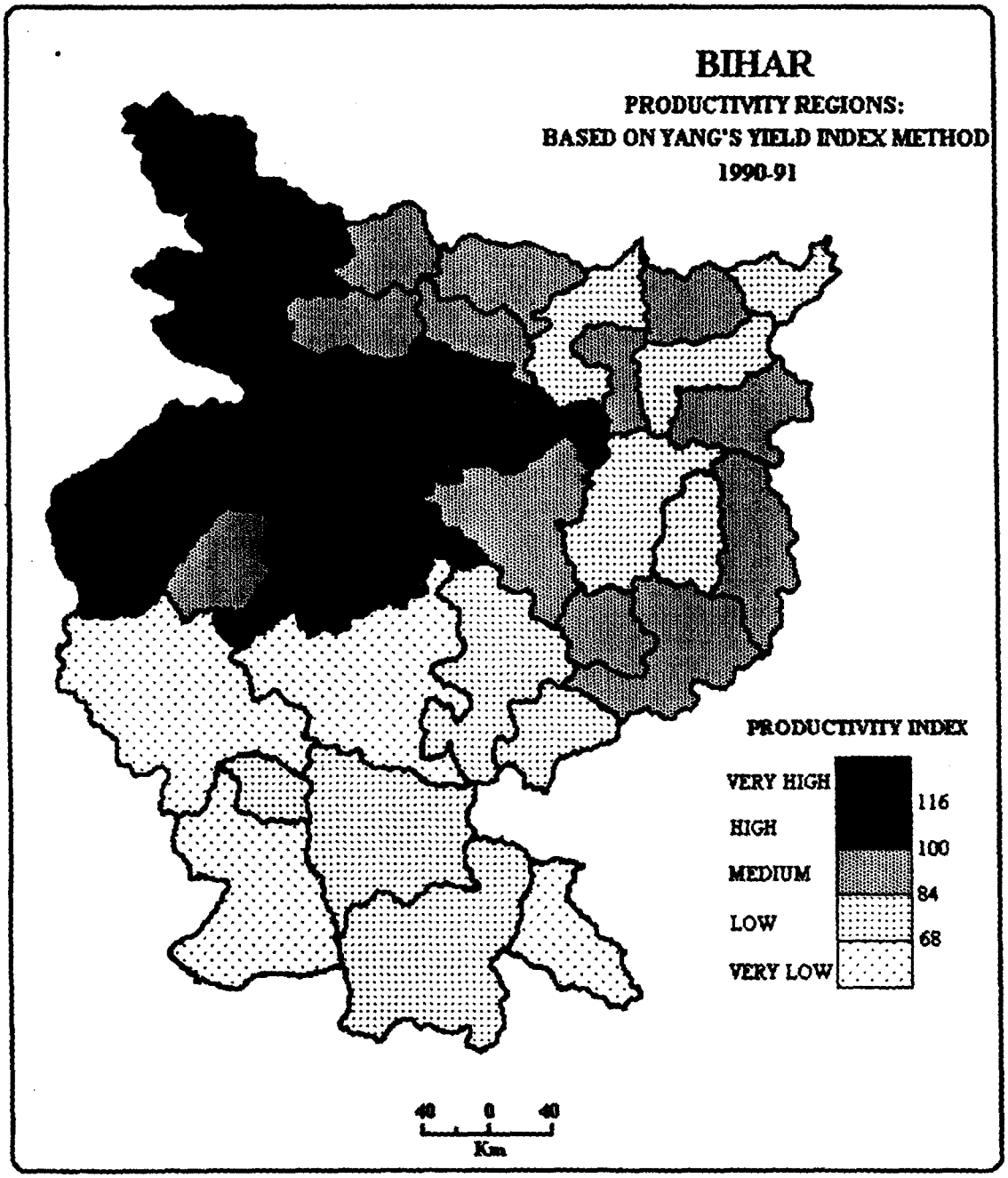

BIHAR
PRODUCTIVITY REGIONS:
BASED ON YANG'S YIELD INDEX METHOD
1990-91
PRODUCTIVITY INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
116
100
84
68
40 0 40
Km

FIG. 8

The majority of the districts come under medium agricultural productivity. There are twelve districts which come under medium grade of agricultural productivity. They form two contiguous regions, one in the northern part of the state which includes the districts of Sitamarhi (96.77), Muzaffarpur (96.34), Madhubani (98.53) and Darbhanga (93.53). the other lies in the central-eastern part of the state and includes the districts of Munger (86.92), Deoghar (98.38), Dumka (94.15), Sahibganj (85.02) and Katihar (90.46). There is a small block of medium agricultural productivity in northern part of the state and includes the districts of Madhepura (96.89) and Araria (86.33). The district of Aurangabad (84.96) also comes under this category of medium agricultural productivity. These medium agricultural productivity areas cover net sown area of 1884 thousand hectares which is 25 percent of area of the state.

The low agricultural productivity region form a contiguous belt from northern-eastern to south-eastern part of the state and includes the districts of Dhanbad (69.01), Girdih (74.61), Lohardaga (77.42), Ranchi (78.58), Godda (79.44) Saharsa (79.78), Bhagalpur (81.47), Kishanganj (82.69), Purnia (82.92) and Singhbhum West (82.87). It covers the net sown area of over 1542 thousand hectares which is 20 percent of the net sown area. The very low agricultural productivity areas are found in southern part of the Bihar as shown in Fig.9. The districts under very low agricultural productivity are Palamu (56.43), Gumla (61.94), Hazaribagh (67.10) and Singhbhum East (51.87). They cover the area of about 877 thousand hectares which is 13 percent of net sown area.

Productivity Regions: Based on Agricultural Output per Hectare (in Rs.) 1980-81

Regional pattern of agricultural productivity on the basis of output per hectare shows a wide range of variation. It varies from a minimum of Rs. 1253 in Palamu to the maximum of Rs. 2696 in Sitamarhi (Appendix B). This variation is further confirmed by the coefficient of variation which is 17 percent.

Regional pattern shows that a distinct and compact region of very high productivity grade is found in the central part of the state as shown in Fig.9. It comprises the districts of Patna (2417.47), Begusarai (2434.76), samastipur (2499.76) and Nalanda (2613.20). The districts of Champaran west (2603.28) and Sitamarhi (2696.04) are also have very high agricultural productivity but they are scattered apart and do not form any identifiable region. The districts of high agricultural productivity are also scattered apart from each other and therefore, they fail to constitute any identifiable region. The districts having high agricultural productivity are Siwan (2128.24), Bhagalpur (2152.60), Giridih (2234.65), Purnia (2238.79), Rohtas (2369.72) and Champaran East (2400.61). The very high and high agricultural productivity region cover an area of 3012 thousand hectare which is 37 percent of the net sown area in the year 1980-81, out of which very high agricultural productivity share is 13 percent.

The regional pattern of the distribution of medium agricultural productivity shows that the major areas of medium agricultural

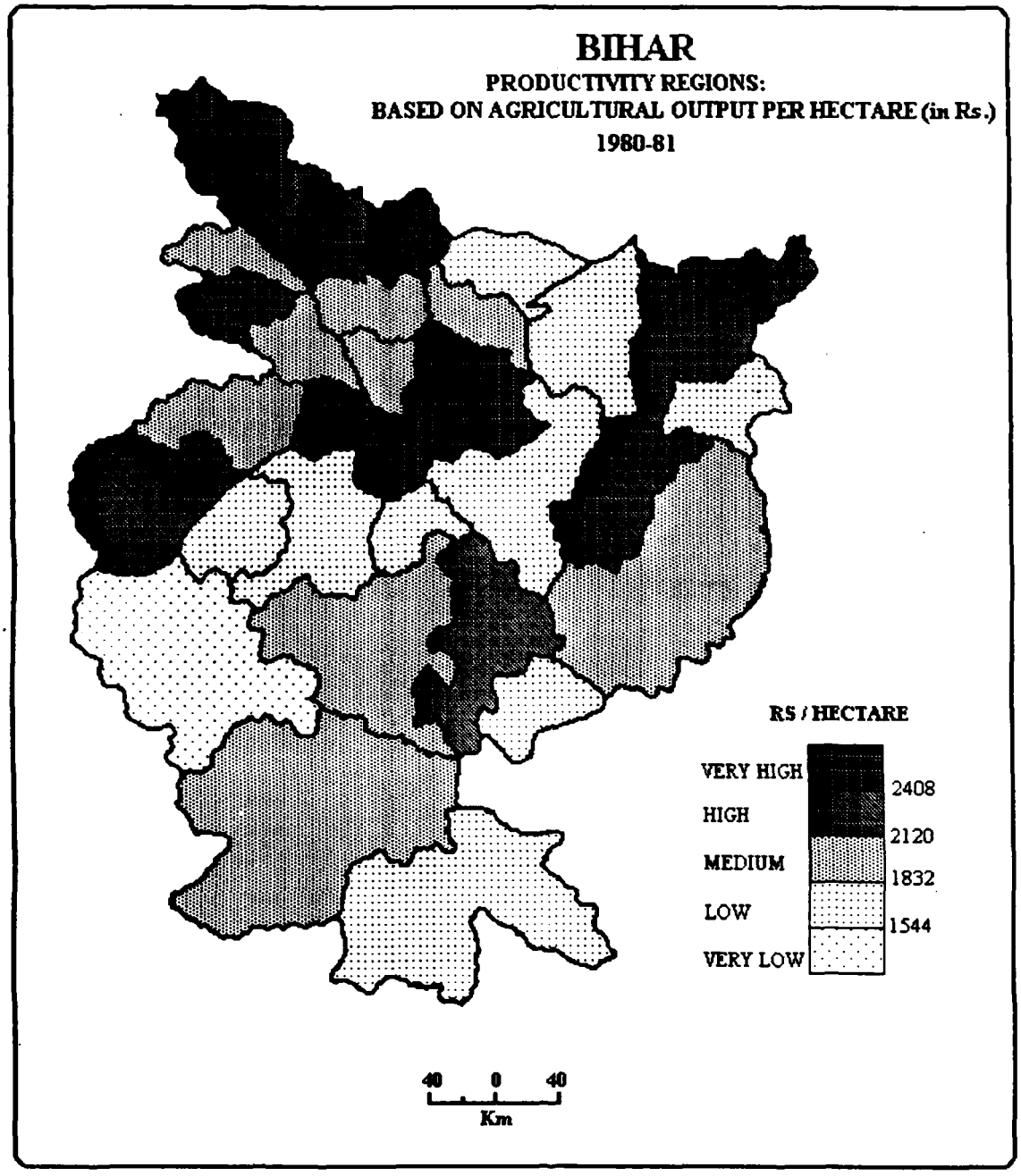

BIHAR
PRODUCTIVITY REGIONS:
BASED ON AGRICULTURAL OUTPUT PER HECTARE (in Rs.)
1980-81
RS / HECTARE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
2408
2120
1832
1544
40 0 40
Km

FIG.9

productivity are mainly concentrated in north-western part and south-central part of the state and form two contiguous regions. The districts of contiguous regions are Gopalganj (1931.69), Saran (1944.32), Bhojpur (1997.24), Vaishali (1991.11), Muzaffarpur (1903.97) and Darbhanga (1880.09). Whereas, the districts of the south-central contiguous region are Nawada (2010.42), Hazaribagh (1847.95), and Ranchi (2025.81). Santhal Pargana (1791.87) also fall in this category of medium agricultural productivity. Medium agricultural productivity region cover area of 2841 thousand hectares which is 34 percent of net sown area of the state.

The study of Fig. 9 reveals that there is a large region of low agricultural productivity in the central-northern part of the state. It includes the districts of Aurangabad, Gaya, Nawada, Munger, Saharsa and Madhubani. The districts of Katihar Dhanbad and Singhbhum also have low agricultural productivity. It is interesting to note that in 1980-81, Palamu is the only district in the category of very low agricultural productivity. The low and very low agricultural productivity region cover an area of 2412 hectares which is 29 percent of the net sown area of the state.

Productivity Regions: Based on Agricultural Output per Hectare (in Rs.) 1990-91

Regional pattern of agricultural productivity on the basis of output per hectare shows a wide variation in Bihar. It varies from a minimum of Rs. 3119 in Singhbhum East to the maximum of Rs. 6934

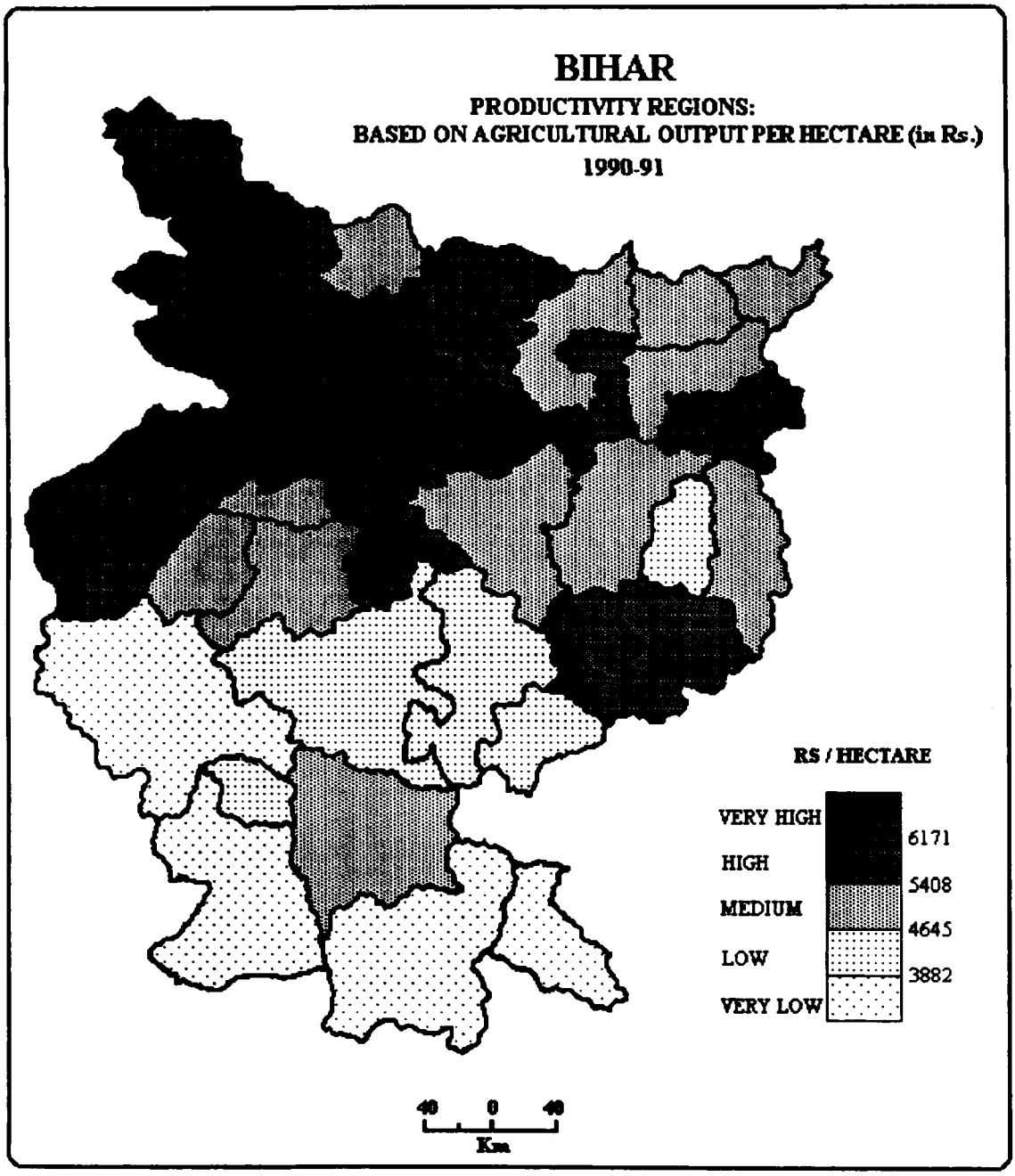

BIHAR
PRODUCTIVITY REGIONS:
BASED ON AGRICULTURAL OUTPUT PER HECTARE (in Rs.)
1990-91
RS / HECTARE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
6171
5408
4645
3882
40 0 40
Km

FIG.10

in Champaran East (Appendix C). This variation is also confirmed by the coefficient of variation which is 17 percent.

Table 5

Bihar: Price Weighted per Hectare Productivity

Grade	Index		Net sown area as% of Gross Cropped area		No. of Districts	
	1980-81	1990-91	1980-81	1990-91	1980-81	1990-91
V. High	Above 2408	Above 6171	13	14	6	6
High	2120-2408	5408-6171	24	38	6	15
Medium	1832-2120	4645-5408	34	30	10	12
Low	1544-1832	3882-4645	26.5	10	8	5
V. low	Below 1544	Below 3882	2.5	8	1	4
Total			100	100	31	42

The regional pattern of agricultural productivity as shown in Fig.10 reveals that there are two small blocks of very high agricultural productivity region in the central and north-western part of the state. It includes the districts of Samastipur (6616.93), Begusarai (6422.01), Khagaria (6329.83), Siwan (6286.34), Saran (6614.14) and Champaran East (6934.79). A contiguous belt of high agricultural productivity is found in the central-northern and central-western part of the state. This comprises the districts of Madhubani (5619.01), Darbhanga (5658.11), Muzaffarpur (5577.41), Vaishali (5691.41) Patna (5689.85), Bhojpur (5742.05), Rohtas (5791.10), Nalanda (6156.15) and Nawada (5892.50). Apart from this there are two small blocks of high agricultural productivity regions, one lies in the north-western part of

the state and includes the districts of Champaran West (6095.20) and Gopalganj (6043.17), the other lies in the south eastern part and includes the districts of Deoghar (5892.08) and Dumka (5472.20), the districts of Katihar (5603.86) and Madhepura (5663.91) also have high agricultural productivity, but they do not form any region. The area under very high and high agricultural productivity region is 3955 thousand hectares which is 52 percent of net sown area, out of which very high agricultural productivity contributes only 14 percent.

The major concentration of medium agricultural productivity is found in central, north-eastern and eastern part of the state and it includes the districts of Sitamarhi (5399.37), Saharsa (4750.83), Araria (5154.05), Kishanganj (4922.23), Purnia (4975.79), Bhagalpur (4947), Munger (5376.53), Sahibganj (4992.57), Jehanabad (4968.70), Aurangabad (5132.40), Gaya (4874.33) and Ranchi (4929.32). There are twelve districts in the medium agricultural productivity grade. They covers an area of about 2318 thousand hectares which is 30 percent of net sown area.

The low and very low productivity grade are mainly confined to southern part of the state. The districts under low agricultural productivity are Godda (4539.24), Giridih (4587.44), Hazaribagh (4137.02) and Lohardaga (4520.59). The districts under very low agricultural productivity grade are Palamu (3394.79), Gumla (3730.02), Singhbhum West (3241.73) and Singhbhum East (3119.45). The area under low and very low productivity region is 1359 thousand hectares which is 18 percent of net sown area.

Factors of Spatial Variations in Agricultural Productivity

The above analysis reveals that the levels of agricultural productivity generally decreases from north to south. There are many factors at work which cause this spatial pattern of agricultural productivity in the state. Among natural factors relief, rainfall and soils may be significant to explain some of the variance in the agricultural productivity. The distribution of rainfall as given in Table 1 indicates that more or less there is an even distribution of rainfall in the state, but topography of south Bihar plateau is such that it allows the quick run off of the rainwater and it is not generally available for irrigation after rainy season. But in north plain it is used for irrigation when the rainy season is over. Some of the agricultural productivity indices shows a regional pattern which is significantly related with the pattern of rainfall and topography. As far as soil factor is concerned, sandy and less fertile soils are concentrated mainly in the southern part of the state (Fig. 6) where agricultural productivity is generally low to very low. With few exceptions, it is interesting to note that all the indices invariably show high and very high level of agricultural productivity in the Bihar plain where soils are very fertile that have been derived from the alluvium deposited by Ganga and its tributaries. These fertile soils are highly suited for the cultivation of wheat, rice, sugar can and maize etc. Per hectare yield as well as money value of crop is high which contributes to the high level of productivity in this

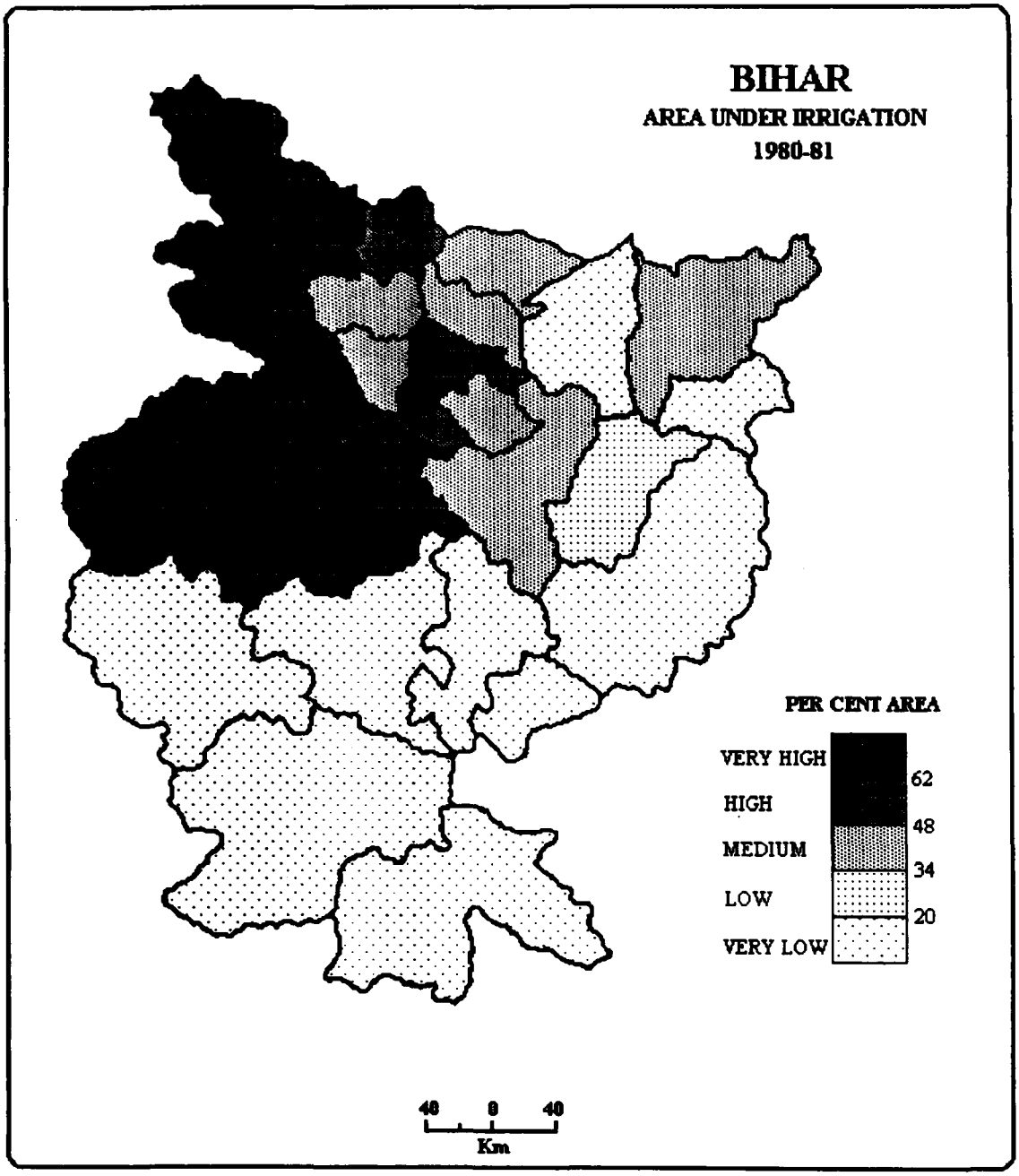

BIHAR
AREA UNDER IRRIGATION
1980-81
PER CENT AREA
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
62
48
34
20
40
0
40
Km

FIG.11

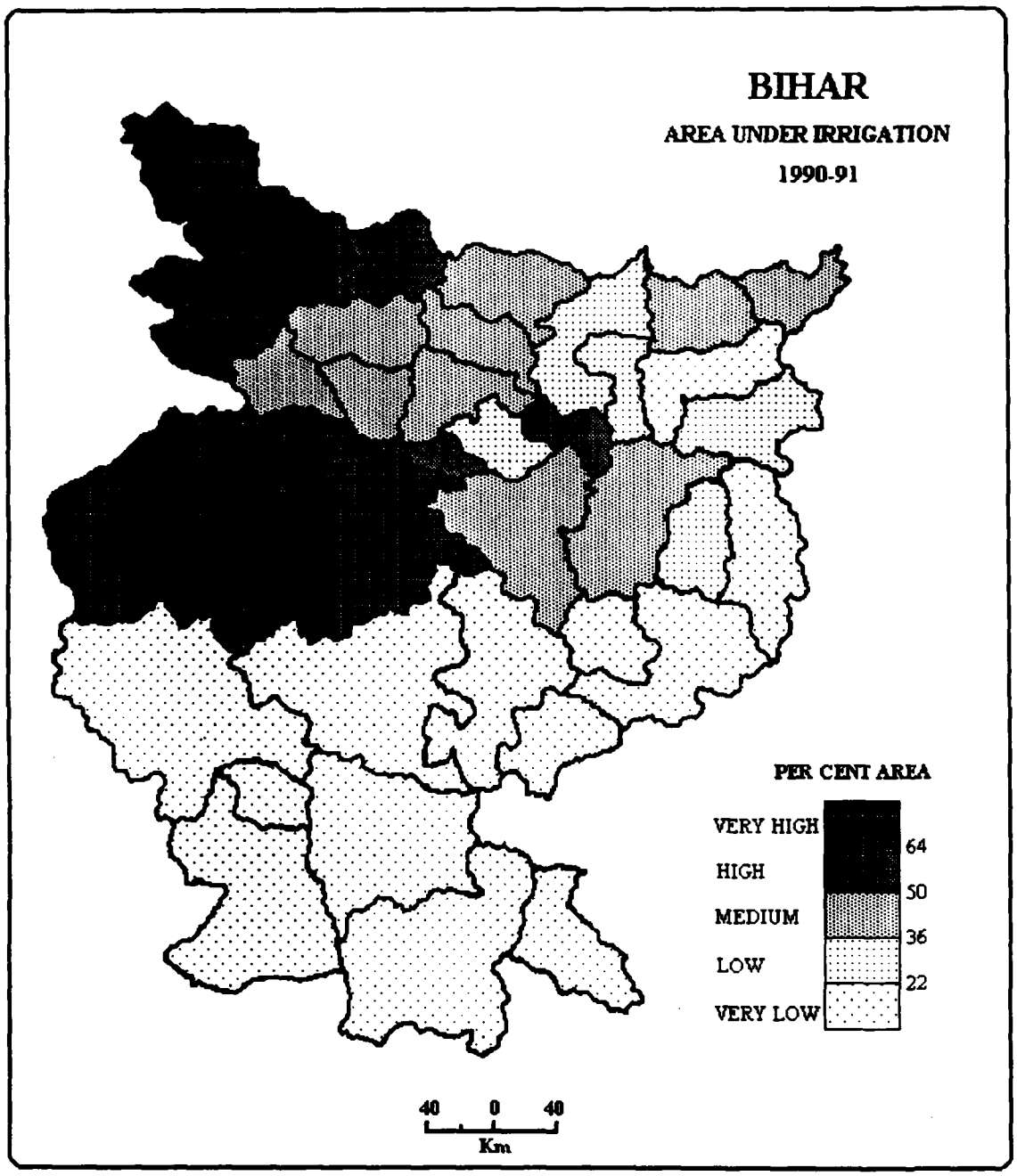

BIHAR
AREA UNDER IRRIGATION
1990-91
PER CENT AREA
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
64
50
36
22
40 0 40
Km

FIG. 12

region.

Among the technological variables irrigation, high yielding varieties of seeds (HYVs), use of fertilizers and agricultural practice of multiple cropping (agricultural intensity) are found as significant correlates of agricultural productivity.

The spatial distribution of area under irrigation in 1980-81 and 1990-91 has been shown in Fig.11 and Fig.12 respectively. Very high and medium grade of percent area is mainly concentrated in central-western and north-western part of the state and it declines towards southern and eastern part of the state. The topography of southern Bihar is rugged and undulating and is not suitable for the construction of canals and tube-wells, the agriculture in this region is mainly dependent on the vagaries of monsoon. The general pattern of irrigation has a marked positive association with the pattern of the levels of agricultural productivity.

High yielding varieties of seeds are generally less resistant to droughts, floods and various diseases and need an efficient management of water and chemical fertilizers. Any lapse on the part of cultivator in application of inputs may substantially reduce the production and productivity. High yielding varieties of seeds are used on small scale due to lack of assured irrigation, capital and chemical fertilizers etc. High yielding varieties of seeds show a close conformity with the spatial pattern of agricultural productivity. The distribution of high yielding varieties of seeds have been depicted in Fig.13 and Fig.14

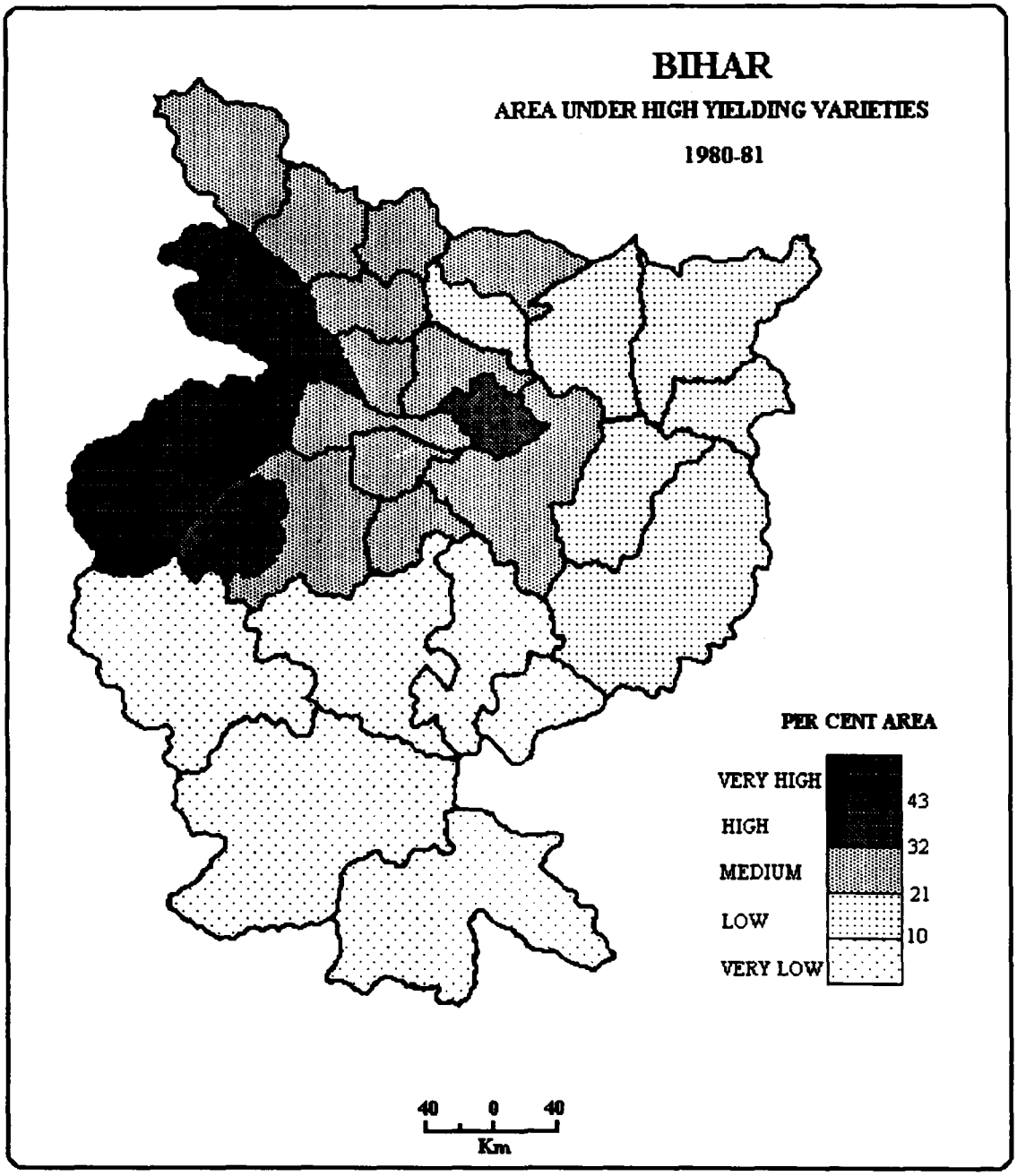

BIHAR
AREA UNDER HIGH YIELDING VARIETIES
1980-81
PER CENT AREA
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
43
32
21
10
40 0 40
Km

FIG.13

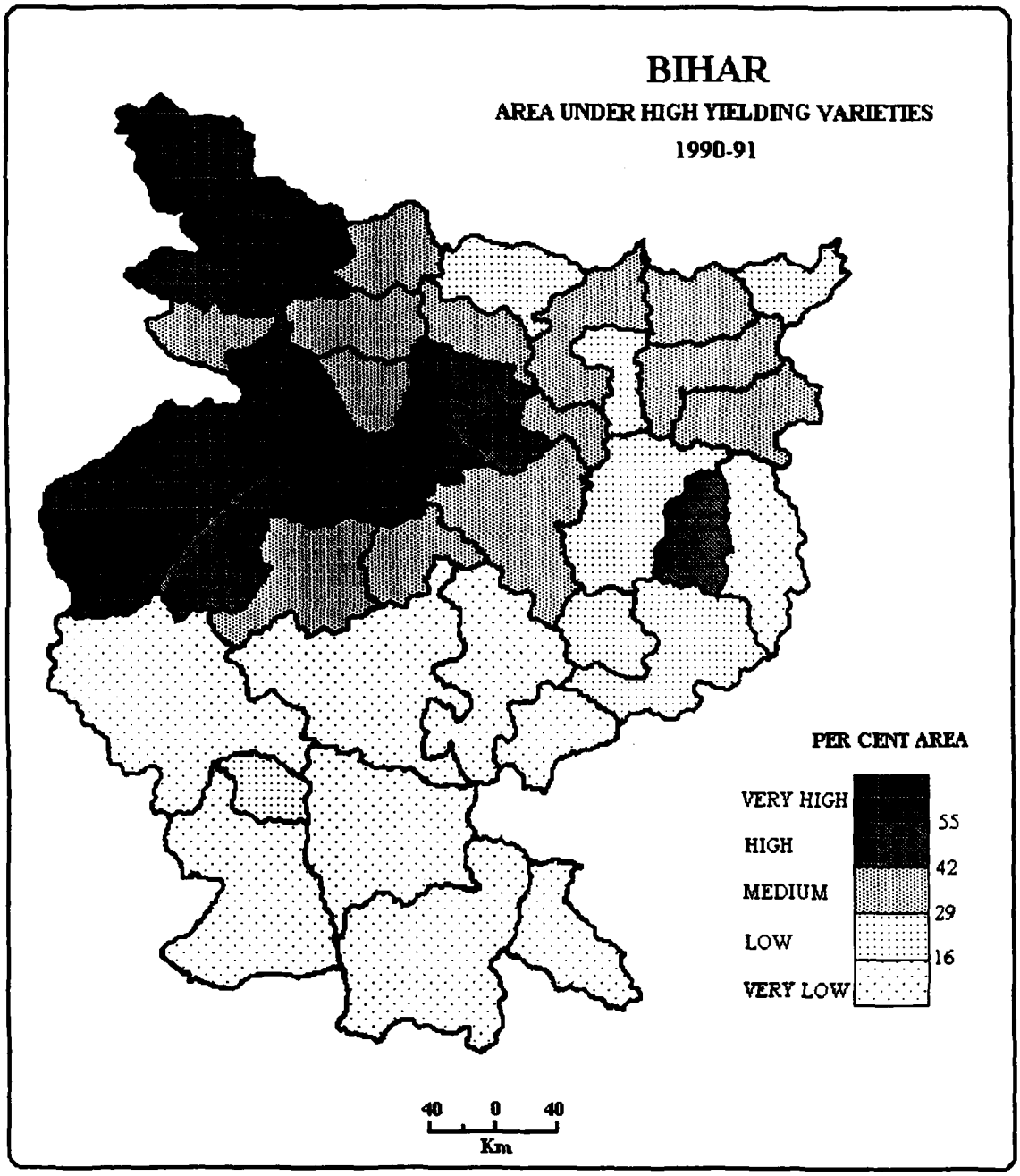

BIHAR
AREA UNDER HIGH YIELDING VARIETIES
1990-91
PER CENT AREA
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
55
42
29
16
40 0 40
Km

FIG. 14

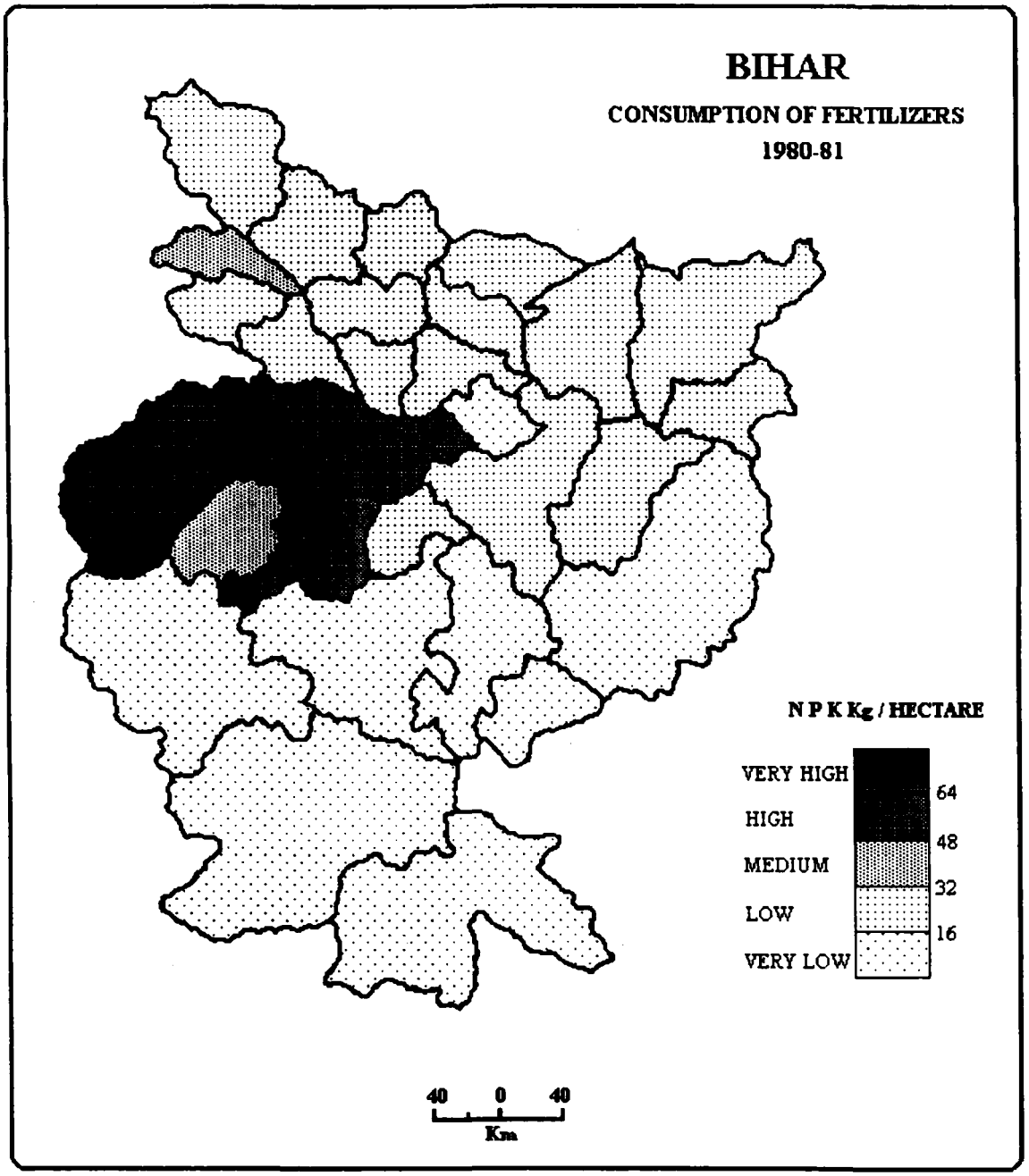

BIHAR
CONSUMPTION OF FERTILIZERS
1980-81
N P K Kg / HECTARE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
64
48
32
16
40 0 40
Km

FIG. 15

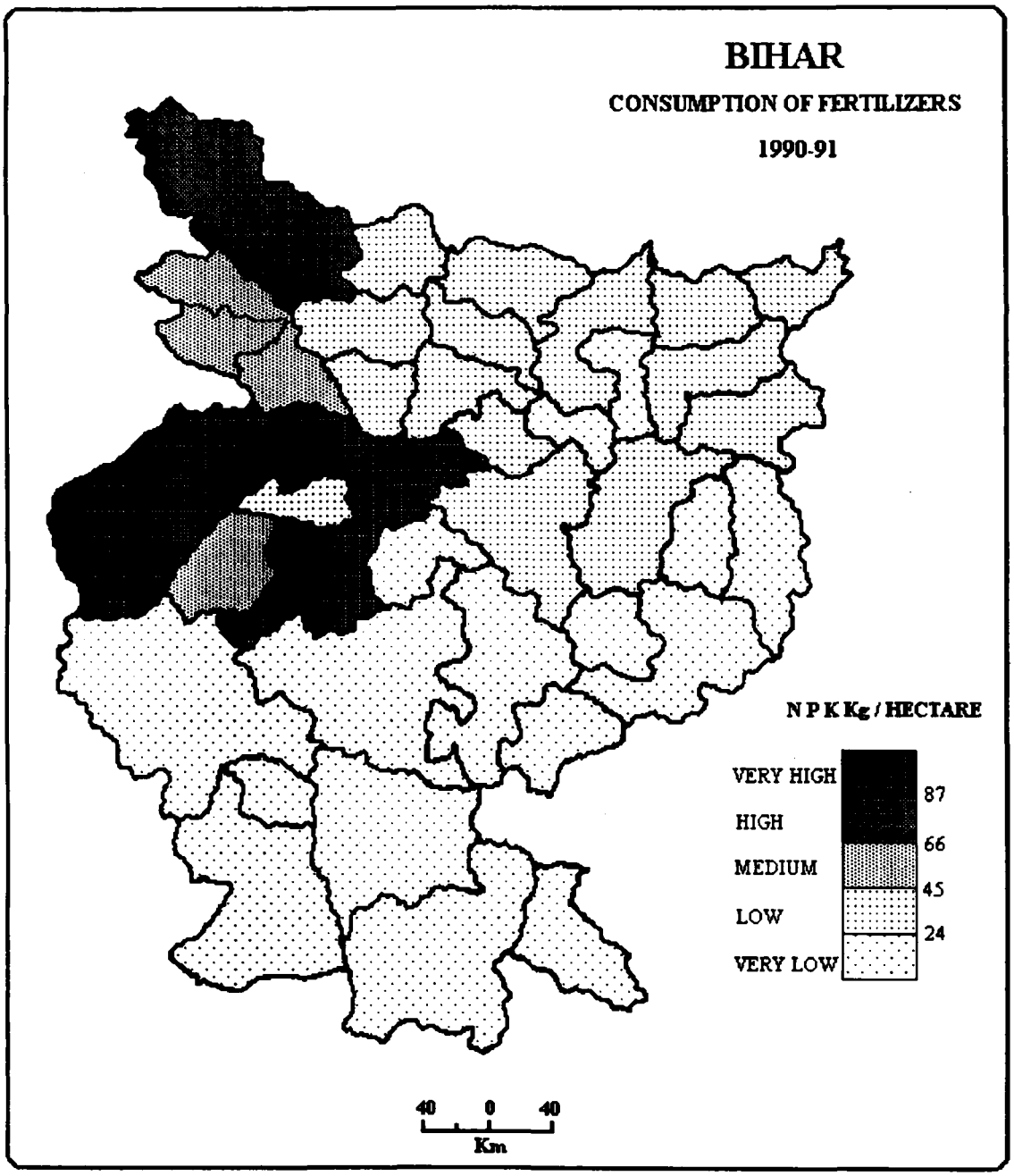

BIHAR
CONSUMPTION OF FERTILIZERS
1990-91
N P K Kg / HECTARE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
87
66
45
24
40 0 40
Km

FIG.16

for the year 1980-81 and 1990-91 respectively. These figures show that very high concentration area under high yielding varieties of seeds is in the central-western part of the state where agricultural productivity has been also recorded very high, while in southern and south-eastern parts of the state the use of HYV of seeds is low resulting into low productivity. The distribution of fertilizers consumption has been shown in Fig.15 and Fig.16. An analysis of these figures reveals that pattern of distribution of chemical fertilizers consumption in the state is similar to that of high yielding varieties of seeds and it is strongly associated with the levels of agricultural productivity.

With minor variations agricultural intensity i.e. proportion of area sown more than once is in close proximity with general pattern of agricultural productivity as shown in Fig.17 and Fig.18. The high and very high levels of agricultural intensity regions are closely associated with the regions of very high and high agricultural productivity. The medium, low and very low agricultural productivity is found in the medium, low and very low levels of agricultural intensity regions.

This examination of possible factors of spatial variation in the levels of agricultural productivity suggests that technological factors are comparatively more strongly associated with the levels of agricultural productivity than the natural factors which have a relatively weak relationship with the levels of agricultural productivity.

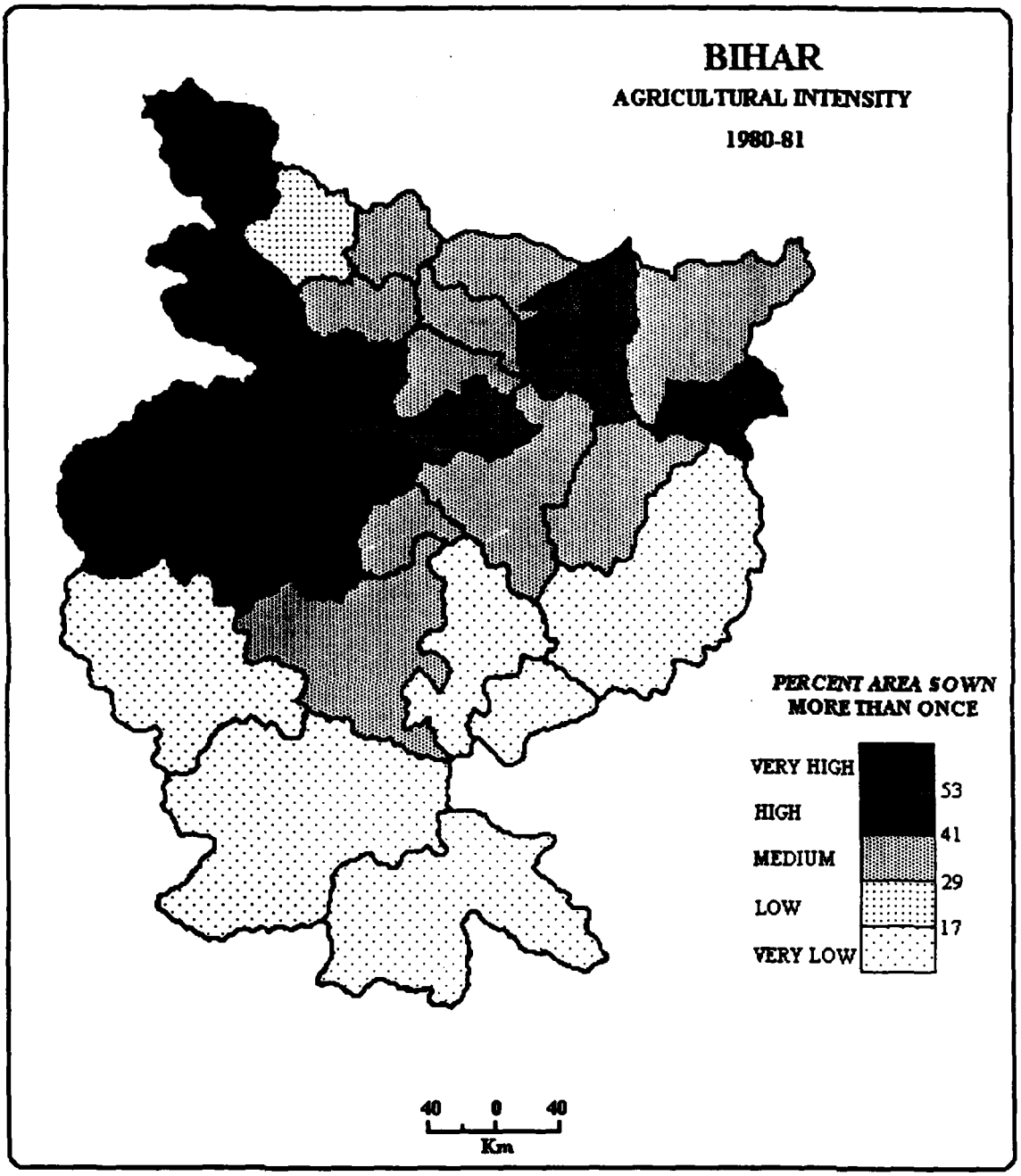

BIHAR
AGRICULTURAL INTENSITY
1980-81
PERCENT AREA SOWN MORE THAN ONCE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
53
41
29
17
40 0 40
Km

FIG.17

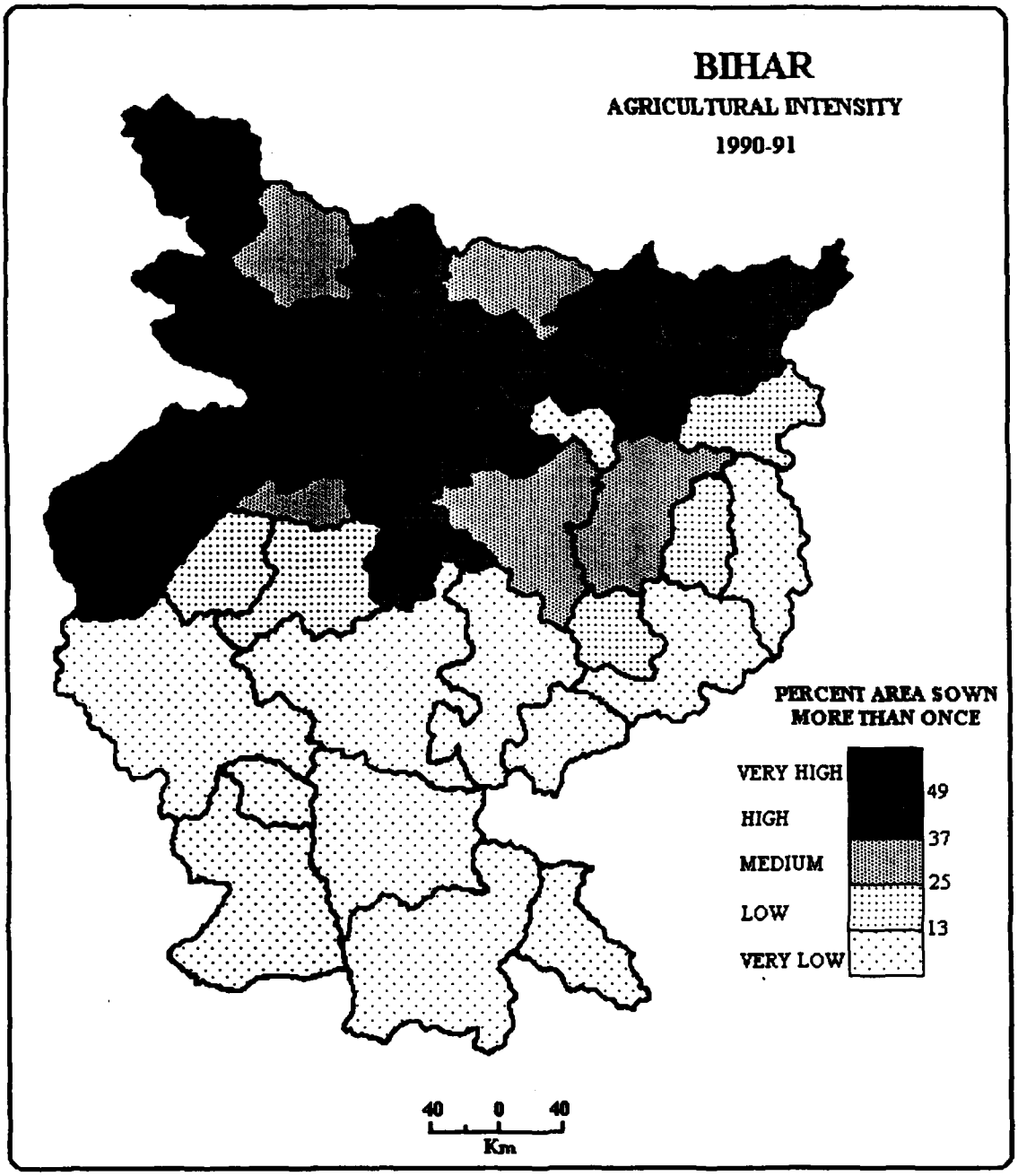

BIHAR
AGRICULTURAL INTENSITY
1990-91
PERCENT AREA SOWN MORE THAN ONCE
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
49
37
25
13
40 0 40
Km

FIG.18

REFERENCES

1. Cereals - Rice, wheat, Barley, Maize.

   Cash Crops - Sugarcane, Potato, Jute.

   Pulses - Gram, Masoor, *Arhar*, Khesari, Pea.

   Oil seeds - Linseed, Rape seed and Mustard,.

2. Yang's, W.Y., *Method of Farm Management Investigation for Improving Farm Productivity*, F.A.O. Rome, 1968.

3. Hussain, Majid, *Agricultural Geography*, Rawat Publication, New Delhi, 1992.

4. Munir, A., *Agricultural Productivity and Regional Development*, Manak Publication Pvt. Ltd., New Delhi, 1992.

CHAPTER 5

DIMENSIONS OF REGIONAL DEVELOPMENT

In the regional analysis of development one comes across regions which are well developed and the people in such region enjoy reasonable standard of living while in others, resource utilization and development is low owing to historical circumstances or other wise, resulting in the underdevelopment of the region whereby people have a poor standard of living. The problem of imbalance in regional development thus assumes a great significance. Regional development, therefore, is inter preted as intra-regional development designed to solve the problems of regions lagging behind. The first connotation of regional development is economic in which the differences in growth, in volume and structure of production, income, employment are taken as the measure of economic progress. However, recently it has been argued that merely economic criteria can not explain the level of development which is a multidimensional concept. Therefore, such variables or criteria should also be employed which indicate progress on technological, social and cultural fronts. Thus development means progress throughout the society. However, at the base of development process lies progress in different sectors of the economy.

For the analysis of the dimensions of regional development, the technique of factor analysis has been applied selecting twenty variables (Appendix D). These variables are selected keeping in mind the personality of the area and the theoretically constructs of the regional

development. These variables fall in the broad categories of: agricultural development; of urbanization and industrialization; development of infrastructure and amenities and social development. Among these categories agricultural development is indicated by six variables namely multiple cropping, irrigation, fertilizer, high yielding varieties of seeds, tractorization, and tube wells and pumpsets. The development of urbanization and industrialization is measured by six variables namely urban population, urban rural ratio, factories, factory workers, secondary workers and tertiary workers. The development of infrastructure and amenities is indicated by six variables namely road length, road density, banks, electrification, hospitals and dispensaries and seed and fertilizer storages. Social development is measured by two variables, literacy rate and schools. In selecting the variables to represent various dimensions of the development, care was taken to select such variables which directly describe the state of the development of the areas. The variables are generally measured on ratio scale and in several cases values are reduced to the total population so that the districts of the region are comparable to each other.

Factor Structure

The factor analysis of 20 variables related to the development of 31 districts in 1980-81 and 42 districts in 1990-91 of the study area has yielded four major factors which together accounted for 91.23 percent and 93.76 percent of the total variance in the regional development of Bihar as shown in Table 6 for the year 1980-81 and 1990-91 respectively.

Table 6

Dimensions of Regional Development in Bihar

Factors	Variance Explained Percent of Total	
	1980-81	1990-91
1. Agricultural Mechanization and Education.	32.05	32.31
2. Infrastructural Development and Industrialization.	21.40	21.90
3. Institutional Development and Agricultural Intensity.	19.08	20.06
4. Urbanization and Modernization.	18.24	19.10
	91.23	93.76

An examination of the rotated factor loadings (Table 7-10) on these factors rendered them to be levelled as dimensions of *agricultural mechanization and education; infrastructural development and industrialization; Institutional development and agricultural intensity; and urbanization and modernization*. As regards the contribution of these factors to the explanation of total variance; it is found that agricultural mechanization and education explains 32.05 and 32.31 percent of the total variance for the year 1980-81 and 1990-91 respectively. Infrastructural development and industrialization 21.40 and 23.10; institutional development and agricultural intensity 19.08 and 22.06 and urbanization and modernization 18.23 and 20.10 percent of the total variance explained for the year 1980-81 and 1990-91 respectively. The first and third

factors are related to the agricultural development which include 51.13 and 52.37 percent of the total variance. This mainly highlights the agricultural specialization of the state. Infrastructural development and industrialization rank second in order while urbanization and modernization is less significant in agriculturally dominated region as it takes fourth position. However, interpretation of these factors needs caution as relationship exhibited by them are complex.

Factor:1 Agricultural Mechanization and Education

Factor first is closely identified with the agricultural mechanization and education (Table 7). The nature of this factor is clearly defined by the high loadings of five agricultural variables and two variables of education. These variables can be regarded as the basic indicants of agricultural mechanization and education.

The positive sign of the variables is associated with the higher development of agriculture and education. Irrigation, tractorization and high yielding varieties all load high and positively on this factor, while literacy, fertilizer, schools, tubewell and pumpsets, electrification and seed and fertilizer storages load moderately on this dimension.

The highest positive loadings are shown by irrigation (0.83585), (0.84178) tractorization (0.80424), (0.80046) for the year 1980-81 and 1990-91 respectively. These variables are closely followed by high yielding varieties of seeds (0.74435) and (0.75970). These positive relationships of agricultural mechanization have moderate loadings with fertilizer (0.59071), (0.69511) and Tubewells and Pump sets (0.55639),

(0.46213) for the year 1980-81 and 1990-91 respectively.

Table 7

Agricultural Mechanization and Education

Variable	Factor Loading	
	1980-81	1990-91
1. Multiple Cropping	0.49450	0.40404
2. Irrigation	0.83585	0.84178
3. Fertilizer	0.59071	0.69511
4. High Yielding Varieties	0.74435	0.75970
5. Tractorization	0.80424	0.80046
6. Tubewell and Pump sets	0.55639	0.50213
7. Urban Population	-0.22301	-0.28065
8. Urban Rural Ratio	-0.06365	-0.13361
9. Factories	0.06377	0.12359
10. Factory Workers	0.06506	0.06095
11. Secondary Workers	0.16541	0.12142
12. Tertiary Workers	0.05761	0.05414
13. Road Length	0.16806	0.1779
14. Road Density	0.15493	0.17013
15. Banks	0.19626	0.16246
16. Electrification	0.42939	0.47360
17. Hospital and Dispensaries	0.05771	0.10549
18. Seed and Fertilizer Storages	0.31566	0.34271
19. Literacy	0.60819	0.65821
20. School	0.59051	0.62432
Percent of Total Variance Explained	32.05	32.31

The relationship among these variables of agricultural development is obvious as the use of high yielding varieties and chemical fertilizer need abundant irrigation. Tractor, in Indian condition is used both on the farm and off the farm. Association of tractorization

with these variables is well understood in the agricultural mechanization of the region. The positive loadings of electrification (0.42939) and (0.47360), and seed and fertilizer storages (0.31156) and (0.34271) reveal the association with agricultural mechanization. Electrification has an important role in the agricultural development of the region because the farm machineries run by the electricity is cheaper than that run on fuel energy. Seed and fertilizer storages too have positive relationship with agricultural development. Seed and fertilizer storages are found in great number in areas where use of high yielding varieties of seeds and fertilizers are more in practice. Thus these two variables of infrastructure are associated with agricultural mechanization.

Education amongst illiteracy in Indian conditions has a high social value. Schools are lacking and of substandard. The high positive loading of school (0.59051) and (0.62432) for the year 1980-81 and 1990-91 respectively variables reveal that the bulk of population lives in rural areas, as agriculture is the main occupation of more than 80 percent population of the area. On the other hand moderate positive loading of literacy (0.40819) and (0.45821) suggests that the area is not fully acquainted with education. This is because the half of the Bihar or whole of the south Bihar is inhabited by tribal people. They are not aware of the significance of education and are stick to the traditional way of living. On the other hand people of north Bihar are some what more literate and aware, which results in overall development of the region. The rate of adoption and diffusion of new agricultural technology is higher in area of northern Bihar which is occupied by

farmers who are more literate and aware than southern Bihar, which is occupied by tribal population. Literate farmers can easily understand the problems of soil, waterlogging, alkalinity and salinity etc. Education is a necessary organ for the development of a society. It is the basis of the creation dissemination system that triggers technical progress, which is the main component of economic growth and increased productivity of labour. Thus there is a dialectical relationship between education and society. Therefore social development and education are inseparable.

Louis malassis emphasis the role of agricultural mechanization in the process of development: Agricultural progress has mainly taken the form of improvement of plant and animal species, the discovery of high yielding varieties, fertilizer technology, plant protection, water technology etc[2].

Mechanization constitutes an essential ingredient of modern agriculture. Increasing use of specialised modern agricultural tools and implements in keeping with the indigenous environment is an inseparable part of the process of modernizing agriculture. Mechanization facilitates the substitution of capital for labour which raises efficiency and productivity which in turn reduces the cost of agricultural production and raises the incomes of farmers. Tractorization is the most common form of mechanization of agriculture. Use of tractors raises both the yield per hectare and cropping intensity. Their use in the conditions of shortages, rising prices of agricultural commodities and the rising cost of human and animal labour is of high social value. In this factor

tractorization has high positive association with tube-wells and pump sets that also lead to an increase in the cropping intensity and yield per hectare which alter the place of agricultural development and raise the incomes of farmers[3].

Agriculture and the economy as a whole and rural communities and society as a whole are interdependent: agriculture often plays a decisive role in economic 'take off' but overall economic growth in turn brings about important changes in the agricultural economy by increasing monetary demand for food stuffs, creating non agricultural employment requiring a transfer of power from the country side to the towns and creating demand for producer and consumer goods in the agricultural sector, whose purchasing power tends to increase. Analysis of the process of development therefore places considerable emphasis on relationships between agriculture and industry. In pre industrial societies where almost the whole population earns its living from the land, the type of farming engaged in is necessarily subsistence farming; during the process of overall development, agriculture becomes more market oriented; in fully industrialised economies agriculture itself tends to become industrialised, that is to say, to adopt the methods and structures of the industrial economy[4]. However, this is not possible without proper education and training.

The spatial dimension of agricultural mechanization and education in Bihar have been plotted in Fig. 19 and Fig. 20. for the year 1980-81 and 19091 respectively. The high positive factor scores on this factor imply irrigation, tractorization, high yielding varieties,

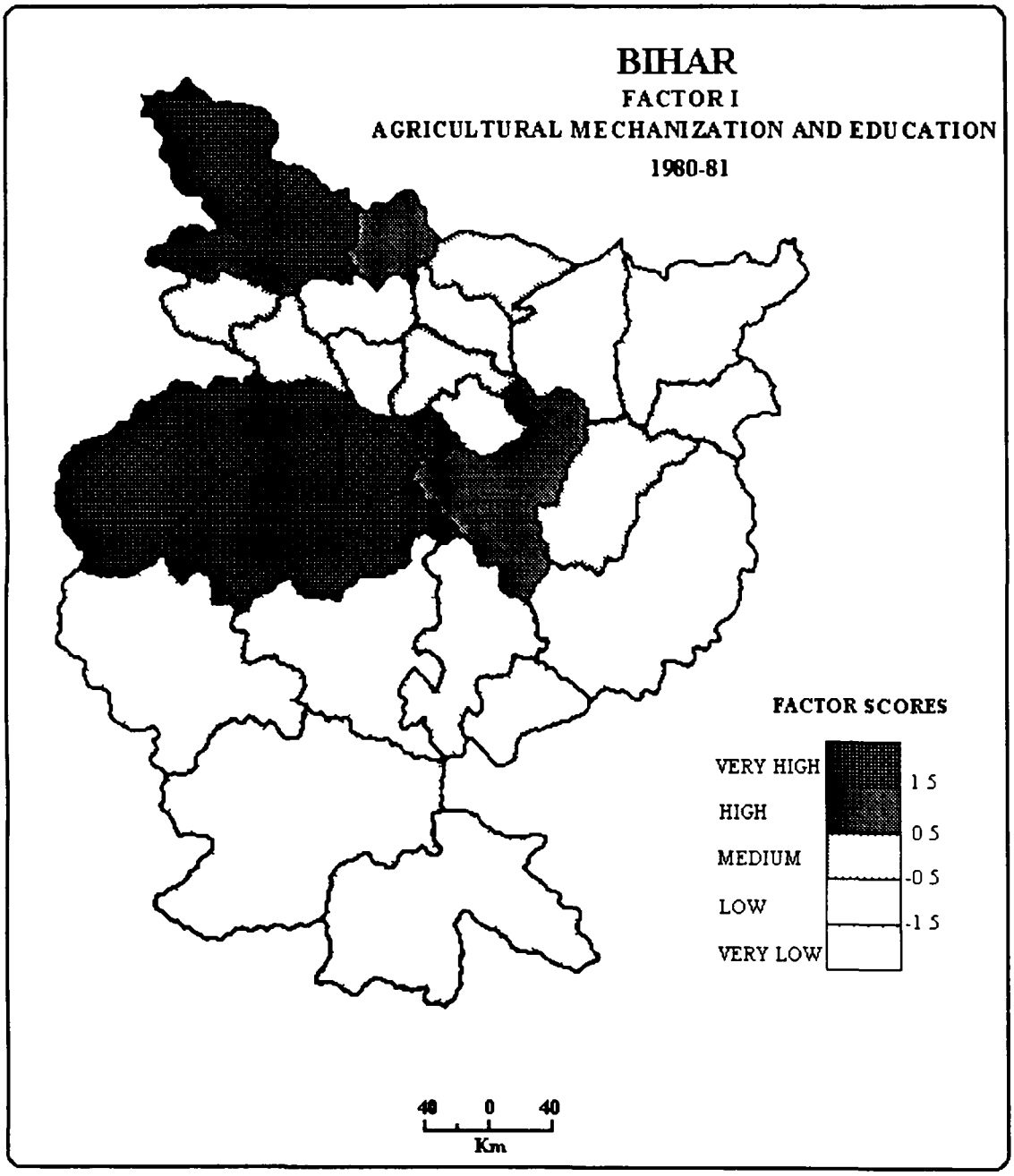

BIHAR
FACTOR I
AGRICULTURAL MECHANIZATION AND EDUCATION
1980-81
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG.19

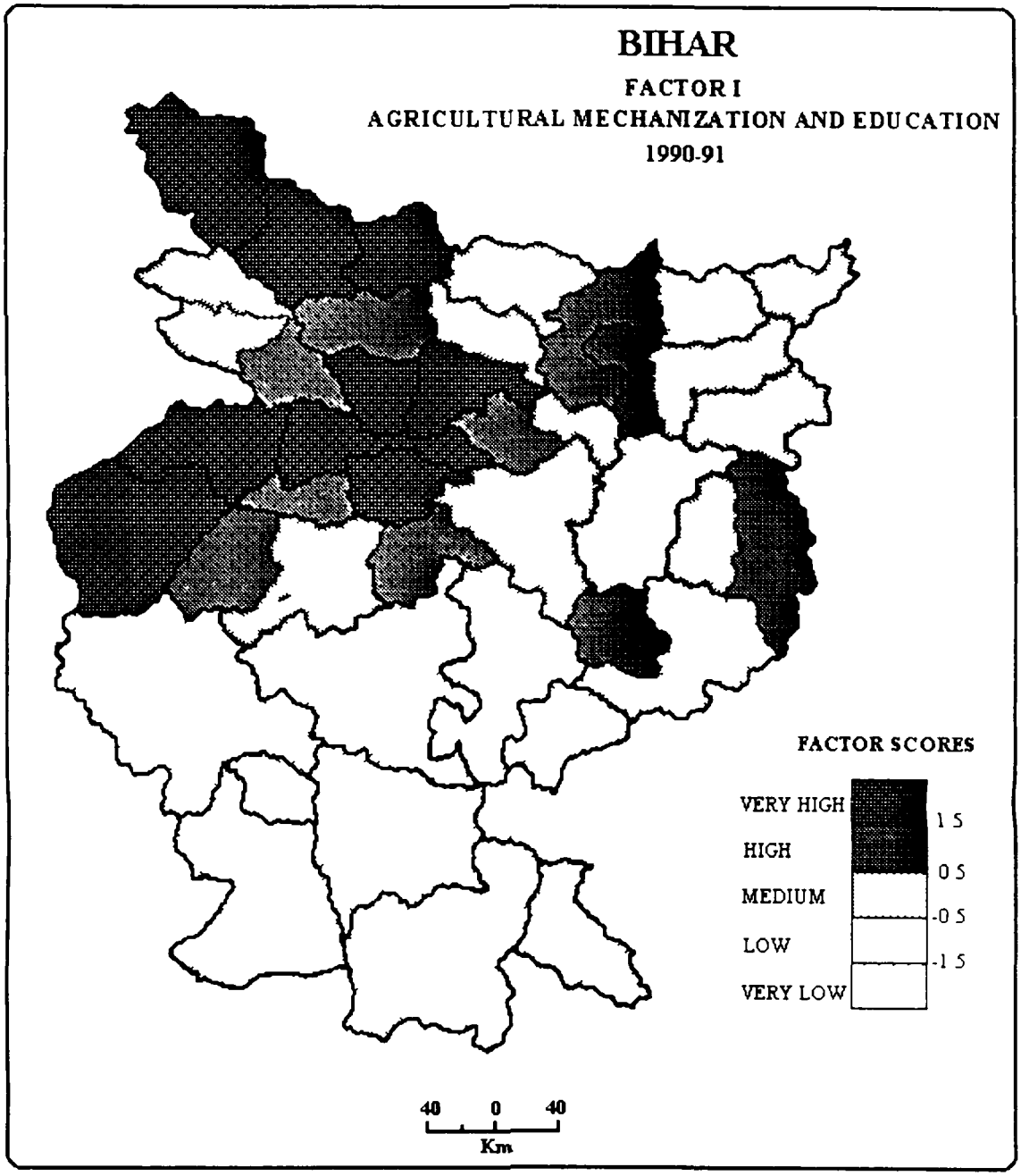

BIHAR
FACTOR I
AGRICULTURAL MECHANIZATION AND EDUCATION
1990-91
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG. 20

tubewells and pumpsets, fertilizer, seeds, and fertilizer storages along with literacy and schools These high factor scores can be identified with the high level agricultural mechanization and education

The standardized factor scores have been divided into five grades (class intervals) of very high, medium, low and very low The very high factor scores are more than + 1 5 standard deviation from the mean (00) The category of high mechanization and education ranges from + 0 5 to + 1 5 standard deviation The medium grade of the factor scores ranging from - 0 5 to + 0 5 standard deviation The factor scores ranging from - 0 5 to -1 5 standard deviation are categorized in low grade of mechanization and education Districts showing factor scores less than -1 5 standard deviation are group in the class of very low agricultural mechanization and education The areas of very high factor scores are concentrated in the north-western part of the state They constitute a contiguous region extending over the districts Bhojpur, Rohtas, Patna, Aurangabad, Gaya, Nalanda and Nawada The other two districts of same grade is West Champaran and East Champaran It is interesting to note that in 1980-81 there is no district under low grade of mechanization and education But there are large number of districts under very low grade of mechanization and education Almost whole of the south Bihar and north-eastern parts of Bihar fall under the category of very low grade of agricultural mechanization and education The situation is almost same in the year 1990-91 except that the number of districts under high and low grade of agricultural mechanization and education have increased

Factor-2: Infrastructural Development and Industrialization

Factor 2 is strongly related to the measures of factories, factory workers, secondary workers, road length, road density and electrification. This dimension of infrastructural development and industrialization represents another component of development. The factories of the region are agro-based as well as basic industries related to iron and steel and oil refinery etc. They are located in cities, towns and urban centres where infrastructural development is higher as compared to rural areas characterising strong positive association with the variables of this factor.

The highest positive loading on this factor in 1980-81 registered by secondary workers (0.67981) followed by factories (0.60998), road length (0.57830) and road density (0.56732) factory workers (0.54507) and electrification (0.46480). The trend is almost same in the year 1990-91 as secondary worker (0.70807) followed by factories (063271), road length (0.61094), road density (0.58626), electrification (0.56392) and factory workers (0.57725). On the basis of strong relationship of these variables this factor can be designated as the dimension of infrastructural development and industialization.

Industrialization has a major role to play in the regional development of the underdeveloped regions. The gap in per capita incomes between the developed and underdeveloped countries are largely reflected in the disparity in structure of their economies, the former are largely industrial

economies, while in the latter, production is confined predominantly to agriculture[5]. Further more, the growth of modern industry provides employment for an underutilized labour force bottled up in agriculture. Industrialization is held to be crucial to development strategies because it radiates stimuli throughout the economy and lift it out of stagnation[6].

Table 8

Industrialization and Infrastructure

Variable	Factor Loading	
	1980-81	1990-91
1. Multiple Cropping	0.22646	-0.25919
2. Irrigation	0.08973	-0.13474
3. Fertilizer	0.05064	0.02068
4. High Yielding Varieties	-0.14462	0.03068
5. Tractorization	0.00277	0.06456
6. Tube wells and Pump sets	-0.09625	-0.13671
7. Urban Population	0.07041	0.08589
8. Urban Rural Ratio	0.06706	0.09122
9. Factories	0.60998	0.63271
10. Factory Workers	0.54507	0.57725
11. Secondary Workers	0.67989	0.70807
12. Tertiary Workers	0.30800	0.39585
13. Road Length	0.57830	0.61094
14. Road Density	0.56732	0.58626
15. Banks	0.08277	0.04106
16. Electrification	0.46480	0.56392
17. Hospital and Dispensaries	0.07241	0.12880
18. Seed and Fertilizer Storages	0.01944	0.15686
19. Literacy	0.03331	0.18173
20. Schools	0.05230	0.14394
Percent of Total Variance Explained	21.398	23.10

The positive loading of road length (0.57830), (0.61094), road density (0.56732), (0.58626) and electrification (0.46480), (0.56392) for the year 1980-81 and 1990-91 respectively reveals the association with industrialization. The road length, road density and electrification has an important role in the industrial development of the region. The industrial machineries are run by electricity which is adequately connected with roads. Thus these variables of infrastructure are highly associated with industrialization. The spatial pattern of industrialization and infrastructure are shown in Fig-21 and Fig. 22 respectively.

In the year 1980-81 there were two contiguous region of very high factor scores of industrialization and infrastructure. One lies in the southern part of the state, which is the store house of the minerals. A large number of minerals are found in small area. It includes the districts of Singhbhum, Ranchi, Hazaribagh and Dhanbad. The other contiguous region of this grade is found in the central-western part of the state and includes the districts of Gaya, Bhojpur, Patna, Begusarai and Munger. There are only two districts under high grade of infrastructural development and industrialization. This includes the districts of Santhal Pargana and Giridih.

The number of districts under medium grade of factor score are two. They are the districts of Bhagalpur and East Champaran. Darbhanga is the only district under low category of infrastructural development and industrialization. The rest of the districts are under very low grade of infrastructural development and industrialization.

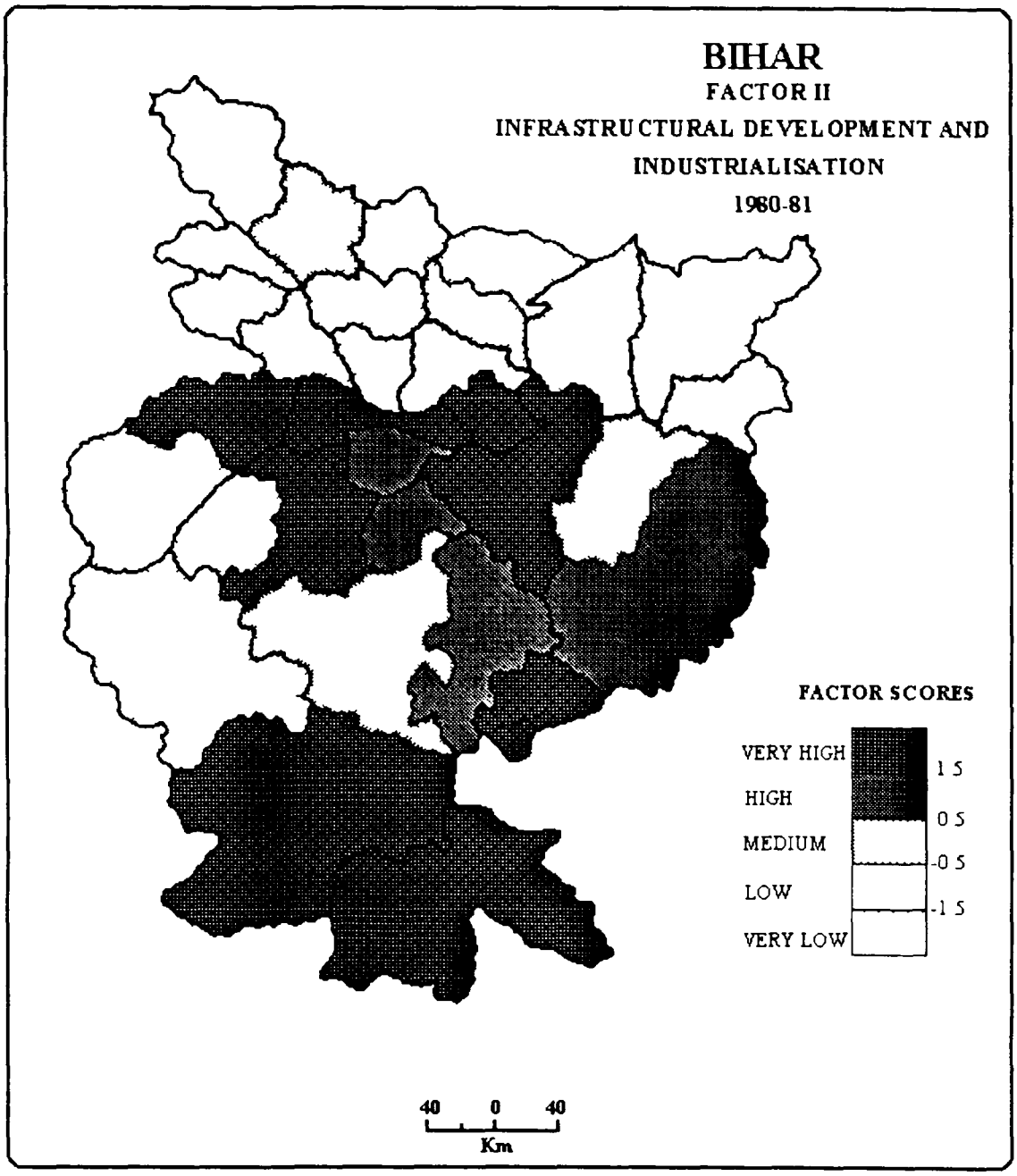

BIHAR
FACTOR II
INFRASTRUCTURAL DEVELOPMENT AND
INDUSTRIALISATION
1980-81
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG. 21

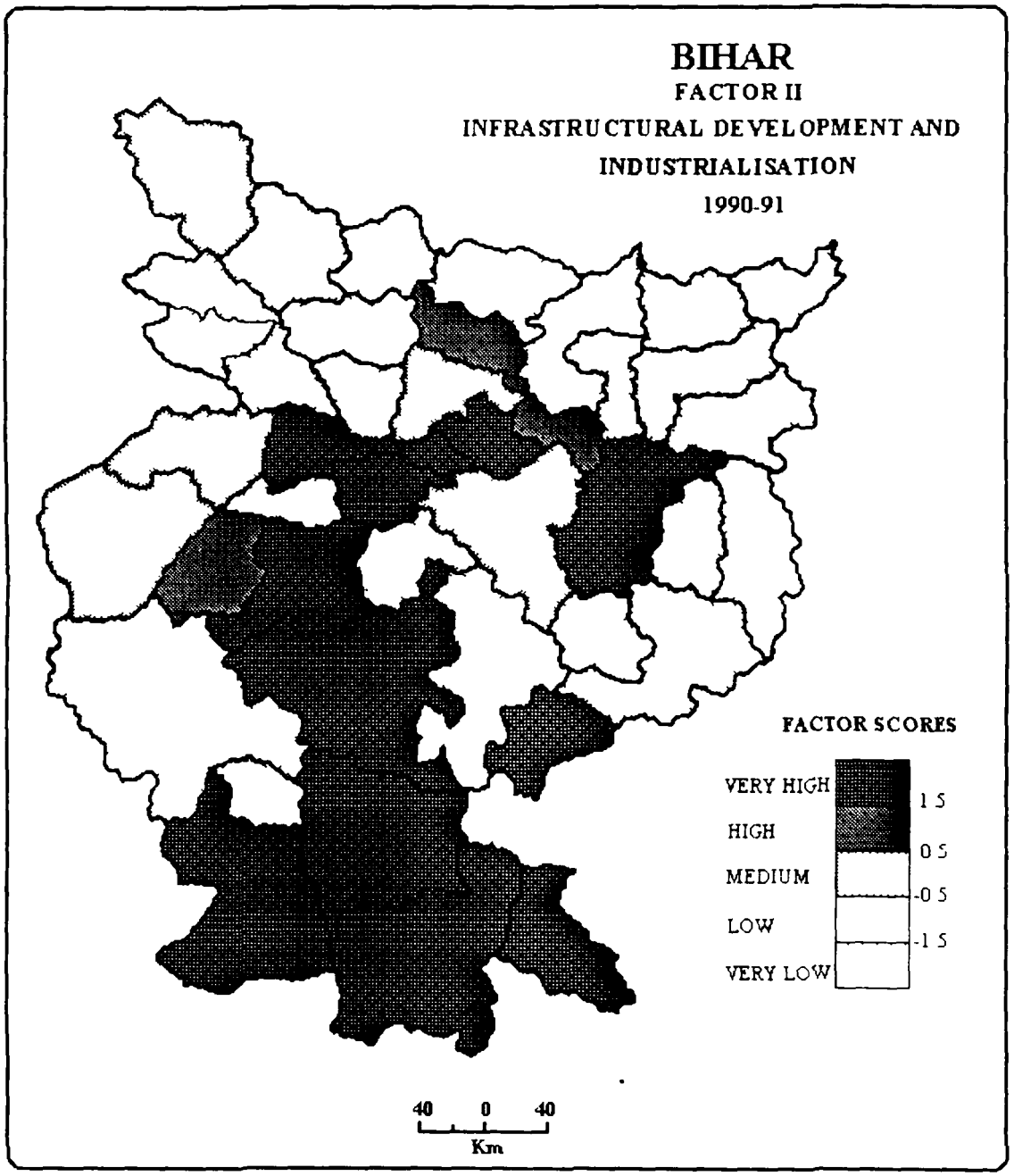

BIHAR
FACTOR II
INFRASTRUCTURAL DEVELOPMENT AND
INDUSTRIALISATION
1990-91
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG. 22

In 1990-91 the situation is almost similar except that some of the very high developed districts come under medium grade of infrastructural and industrialization development , as in the case of Bhojpur which was among very high developed district in 1980-81. Now it has come under medium grade of infrastructural development and industrialization.

The districts under very high grade of infrastructural development and industrialization form a contiguous region in the south central part of the state. It includes the districts of East Singhbhum, West Singhbhum, Gumla, Ranchi, Hazaribagh, Gaya, Nalanda, patna and Begusarai. Besides this there are two districts which comes under very high grade but do not form any contiguous region. They are the districts of Dhanbad and Bhagalpur. The number of district under very high factor score of infrastructural development and industrialization increased not only due to the infrastructural development and industrialization but also due to the fragmentation of districts in 1991. The number of districts under high factor score has increase to three as compared to two in 1980-81. It includes the district of Aurangabad, Khagaria and Darbhanga.

The districts under medium grade of infrastructural development and industrialization are West Champaran, Rohtas, Bhojpur Samastipur and Munger, whereas, the districts of Dumka, Katihar, Purnia Madhepura and East champaran fall under low grade of factor scores. The rest of the districts which are 18 in number falls under very low grade of factor scores of infrastructural development and industrialization.

Factor-3: Institutional Development and Agricultural Intensity

Institutional development and agricultural intensity is the third important factor explaining 19.55 and 22.35 percent of the total variance for the year 1980-81 and 1990-91 respectively. It is closely related with the variables of banks, multiple cropping, seed and fertilizer storages and tertiary workers (Table 9). The high loading on these dimension suggests that this is the dimension of institutional development and agricultural intensity. The rotated factor shows that the highest loading is by banks (0.70856), (0.65314), which is followed by multiple cropping (0.61956), (0.57492). In addition to these tertiary workers (0.34076), (0.36271) electricity (0.44296), (0.48127) and seed and fertilizer storages (0.31330), (0.36351) are also load moderately on this factor.

The positive sign of the variables indicate higher institutional development and agricultural intensity. The association of banks with the variables seed and fertilizer storages, tertiary workers, electricity and multiple cropping is well under stood. Bank establishments are found in areas that are more productive and economically well off. Datt and Sundharam point out the importance of banks in Indian Agriculture[7]. Majority of the farmers need finance not only for production purposes but also for consumption purposes. Traditionally the farmers are accustomed to spend beyond their means on births and deaths, on marriages and other social and religious occasions. However, the establishment of regional rural banks in an agricultural

areas is a step forward in the developing economies. The main objective of the regional rural banks is to provide credit and other facilities particularly to the small and marginal farmers, agricultural labourers, artisans and small entrepreneurs so as to develop agriculture, trade, commerce, industry and other product activities in the rural areas. Thus rural banks have an important role to play in the rural economy as they have to act as alternative agencies to provide institutional credit in rural areas.

Productivity of land can be explained by the positive relationships of the variables of multiple cropping and fertilizers, The employment of tertiary workers is again high in areas of bank establishments. Besides, it associated with seed and fertilizer storages. Thus the institutional development and agricultural intensity is the most important dimension in the regional development of Bihar.

Table 9

Institutional Development and Agricultural Intensity

Variable	Factor Loading	
	1980-81	1990-91
1. Multiple Cropping	0.61956	0.57492
2. Irrigation	0.16769	0.17359
3. Fertilizer	0.17788	0.25380
4. High Yielding Varieties	0.06029	0.17576
5. Tractorization	0.12985	0.16897
6. Tubewells and Pumpsets	0.07565	0.03357
7. Urban Population	0.05312	0.06202
8. Urban Rural Ratio	0.01212	0.05430
9. Factories	0.06031	0.10532

10. Factory Workers	0.13251	0.09799
11. Secondary Workers	0.10440	0.13010
12. Tertiary Workers	0.34076	0.36271
13. Road Length	0.15440	0.13010
14. Road density	0.19054	0.21864
15. Banks	0.70856	0.65314
16. Electricity	0.44296	0.48127
17. Seed and Fertilizer Storages	0.31380	0.36351
18. Hospital and Dispensaries	0.00282	0.15460
19. Literacy	0.10502	0.24856
20. School	0.05884	0.11080
Percent of Total Variance Explained	19.55	22.35

Fig.23 and Fig. 24 shows the spatial differentiation of institutional development and agricultural intensity in Bihar for the year 1980-81 and 1990-91 respectively. The Fig. 23 shows that in 1980-81 the areas of very high factor scores form two small compact regions in the north-western part of the state. The first region, which lies in the extreme north western part of the state includes the districts of West Champaran, East Champaran and Sitamarhi. The other region lies in the northern-central part include the districts of Patna, Nalanda, Samastipur and Begusarai. The district of Rohtas having very high factor score lie in the extreme west of the state. There are three districts of high factor scores of institutional development and agricultural intensity. But they do not form any significant region. It includes the districts of Gopalganj, Siwan and Vaishali.

The number of districts having medium grade of factor score are four. They are scattered in the northern part of the state. It includes the districts of Bhojpur, Muzaffarpur, Purnia and Bhagalpur. The rest

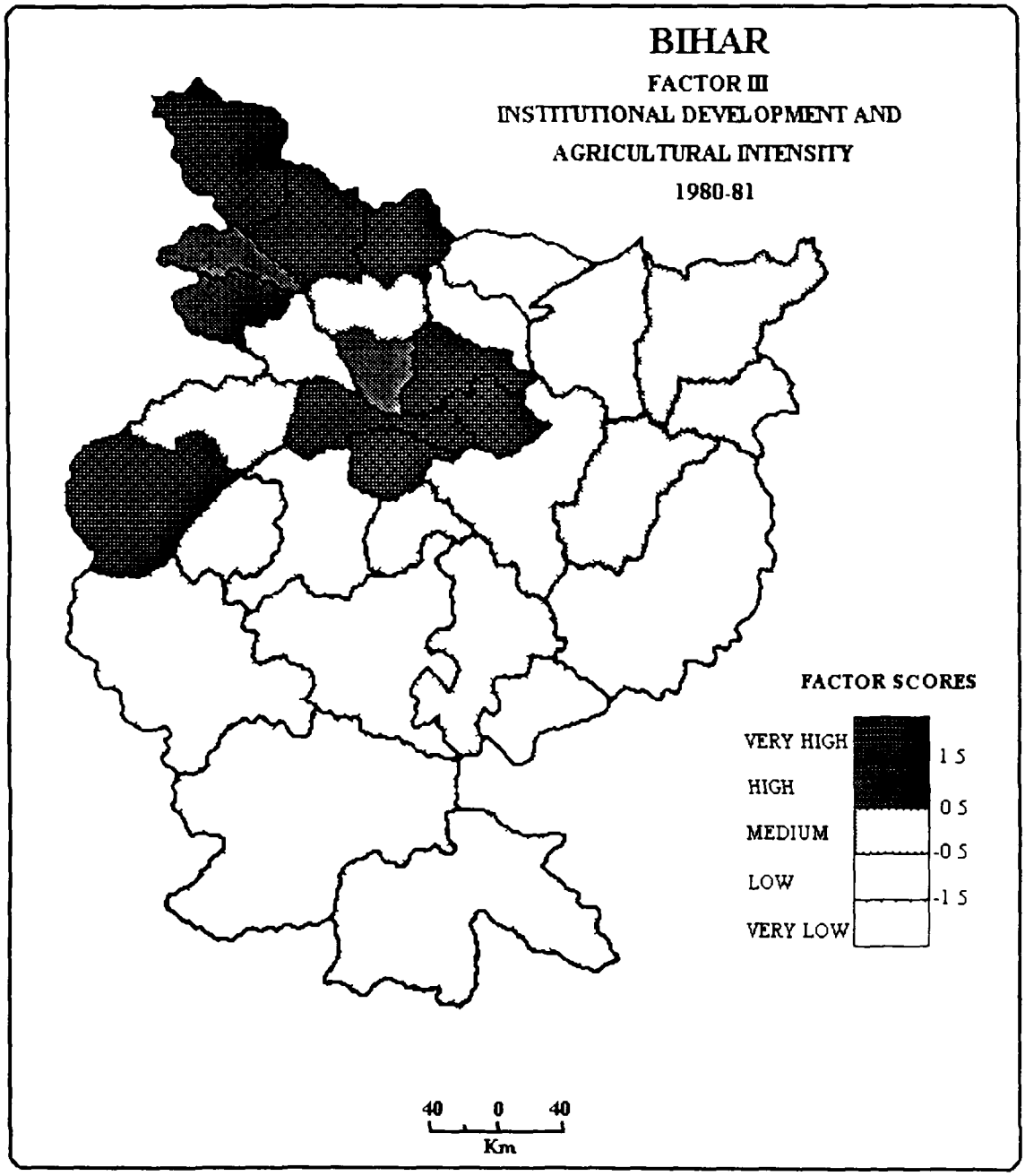

BIHAR
FACTOR III
INSTITUTIONAL DEVELOPMENT AND
AGRICULTURAL INTENSITY
1980-81
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG.23

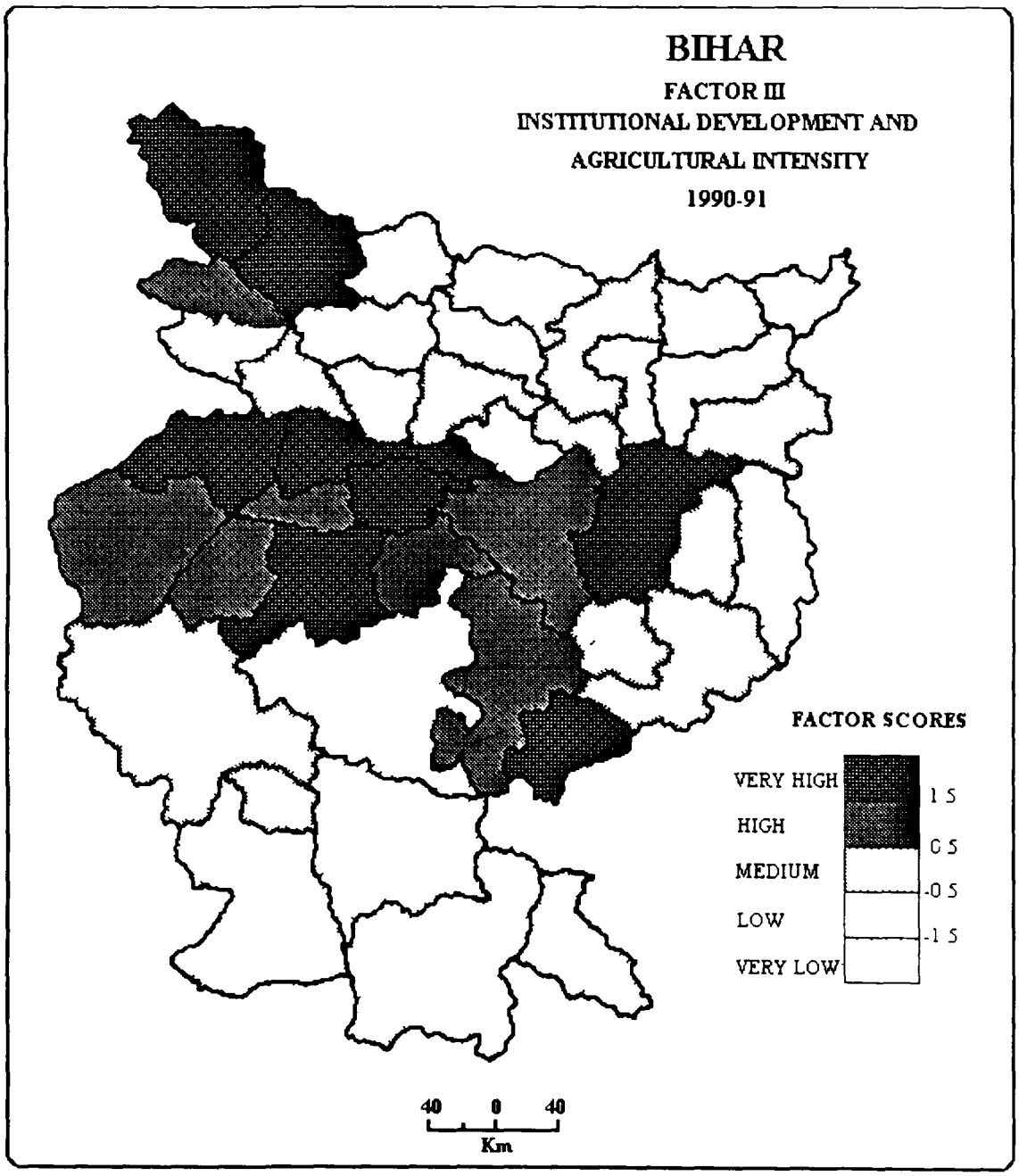

BIHAR
FACTOR III
INSTITUTIONAL DEVELOPMENT AND
AGRICULTURAL INTENSITY
1990-91
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG. 24

of the districts either have low or very low grade of factor scores of institutional development and agricultural intensity.

In 1991 the situation is somewhat changed as shown by Fig 24. The districts have very high grade of factor scores are. West Champaran; East Champaran in the extreme north-west, Bhojpur, Patna, Nalanda and Gaya in the central-western and Bhagalpur and Dhanbad in the eastern and south-eastern part of the state. They do not form any significant region except that of central -western districts. The areas of high factor scores form two small regions one lies in the central-western part and includes the districts of Rohtas and Aurangabad and the other lies in the south -central part of the state and includes the districts of Munger, Nawada and Giridih. Gopalganj is the other district which falls under this category but fails to form any region.

The areas under medium grade of factor scores in institutional development and agricultural intensity form three very small region. It includes the districts of Saharsa, Khagaria and Samastipur in the northern part; the districts of Dumka Deoghar and Dumka in the eastern part and third region includes the districts of Palamu and Lohardaga in south-western part of the state. Apart from this there are two more districts having medium grade of factor scores are scattered in the different part of the state. The majority of the districts either have low or very low factor scores of institutional development and agricultural intensity.

Factor 4: Urbanization and Modernization

Factor 4 is the important dimension of regional development in Bihar. Urban rural ratio and urban population denote urbanization while literacy and factories are the sign of modernization in state like Bihar which is largely backward. Table 10 shows the loading on this factor. Urban rural ratio load highest (0.66097), (0.71348) respectively in the year 1980-81 and 1990-91 followed by urban population (0.57501), (0.64126). Literacy has moderately loaded with (0.41184), (0.40609) followed by factories with (0.38195), (0.34738) respectively in the year 1980-81 and 1990-91. One possible reason should be given for the decrease of literacy and factories in year 1991 in comparison to 1981 is that population has increased more rapidly than the above discussed variables. Urbanization and modernization go side by side. Urban population has strong positive association with literacy. This clearly indicates a higher percentage of literacy in urban areas than in rural areas.

Literacy is a sign of modernization amongst mass illiteracy in Bihar. Factories load positively on this dimension. This relationship indicates urban influence on adjoining rural areas i.e. urbanization and industrialization go side by side. Level of urbanization is also consider to be an indicator of development. Sharma[8] (1972) established relationship between degree of urbanization and level of economic development in Chotanagpur by telescoping the effect of urbanization in the perspective of industrial development creation of sectoral employment, generation of sectoral income and that of per capita

income. He found that urbanization and per capita income have perfect positive correlations

Table 10

Urbanization and Modernization

Variable	Factor Loading	
	1980-81	1990-91
1. Multiple Cropping	0.06909	0.00310
2. Irrigation	0.02113	0.11938
3. Fertilizer	0.07357	0.12083
4. High Yielding Varieties	0.06928	0.08162
5. Tractorization	-0.11073	-09213
6. Tubewells and Pumpsets	-0.13761	-0.08113
7. Urban Population	0.60501	0.64126
8. Urban Rural Ratio	0.66097	0.71348
9. Factories	0.38195	0.34738
10. Factory Worker	0.05260	0.08126
11. Secondary Worker	0.10167	0.12363
12. Tertiary Worker	0.05179	0.06731
13. Road Length	0.15286	0.17371
14. Road Density	0.16846	0.14361
15. Banks	0.05361	0.08131
16. Electrification	0.25877	0.30169
17. Seed and Fertilizer Storages	-0.10316	-0.08413
18. Hospital and Dispensaries	0.40106	0.37369
19. Literacy	0.56073	0.55139
20. School	0.31069	0.35071
Percent of Total Variance Explained	18.24	20.10

In an underdeveloped country with a traditional social structure, which is going through a process of socio-economic change under conditions of political democracy, free migration of population has

wider economic, political and cultural aspects. This internal migration induced by small, isolated pockets of prosperity in a country in which basic development is extremely uneven in spatial terms, has the perverse effect of accentuating regional inequality. There is overwhelming evidence that the country side expels not necessarily the most efficient and enterprising workers, but vast masses of landless peasants and marginal farmers who fall below the margin and are unable or unwilling to carry on as floating labourers in the rural areas. When they flock to the cities they create a perverse type of urbanization, which has by now became a dangerous potent of economic, social and political instability. Thus the emergence of such cities, towns and growth centres have their own socio-economic and regional characteristics. No doubt urbanization brings change in developmental process but at the same time it brings regional instability too[9].

The spatial pattern of urbanization and modernization is shown is Fig 25 and Fig.26 respectively for the year 1980-81 and 1990-91. The high factor scores on this dimension mean a high rate of urbanization and modernization. An examination of the Fig. 25 reveals that there is a compact region of very high factor scores of urbanization and modernization in the central part of the state which includes the district of Patna, Gaya, Nalanda and Vaishali. There are two more districts under this grade but hey do not form any contiguous region, it includes the district of Dhanbad and Singhbhum. There are three scattered districts having high grade of urbanization and modernization. It includes the districts of Ranchi, Girdih and Aurangabad.

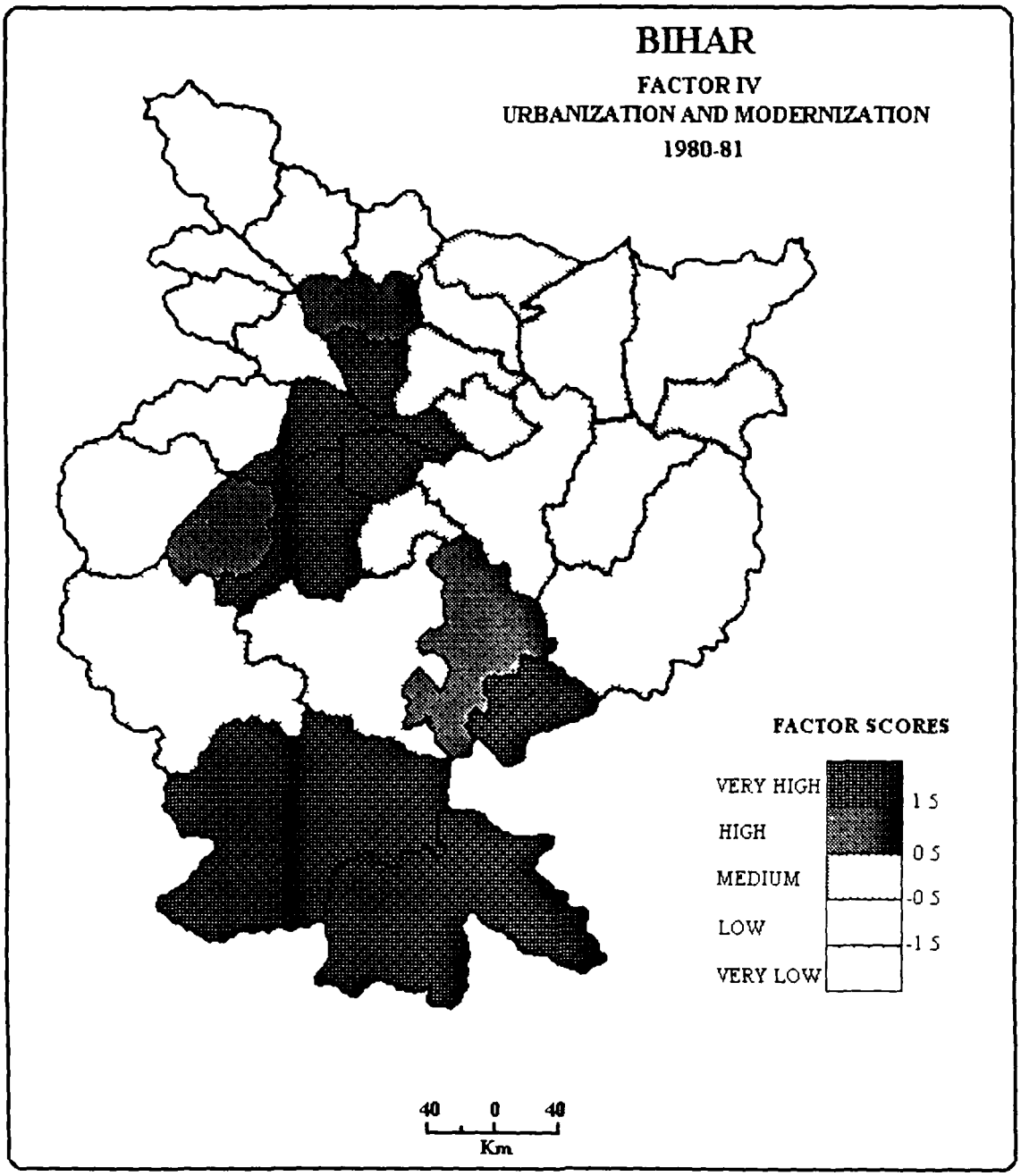

BIHAR
FACTOR IV
URBANIZATION AND MODERNIZATION
1980-81
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
-1 5
40 0 40
Km

FIG. 25

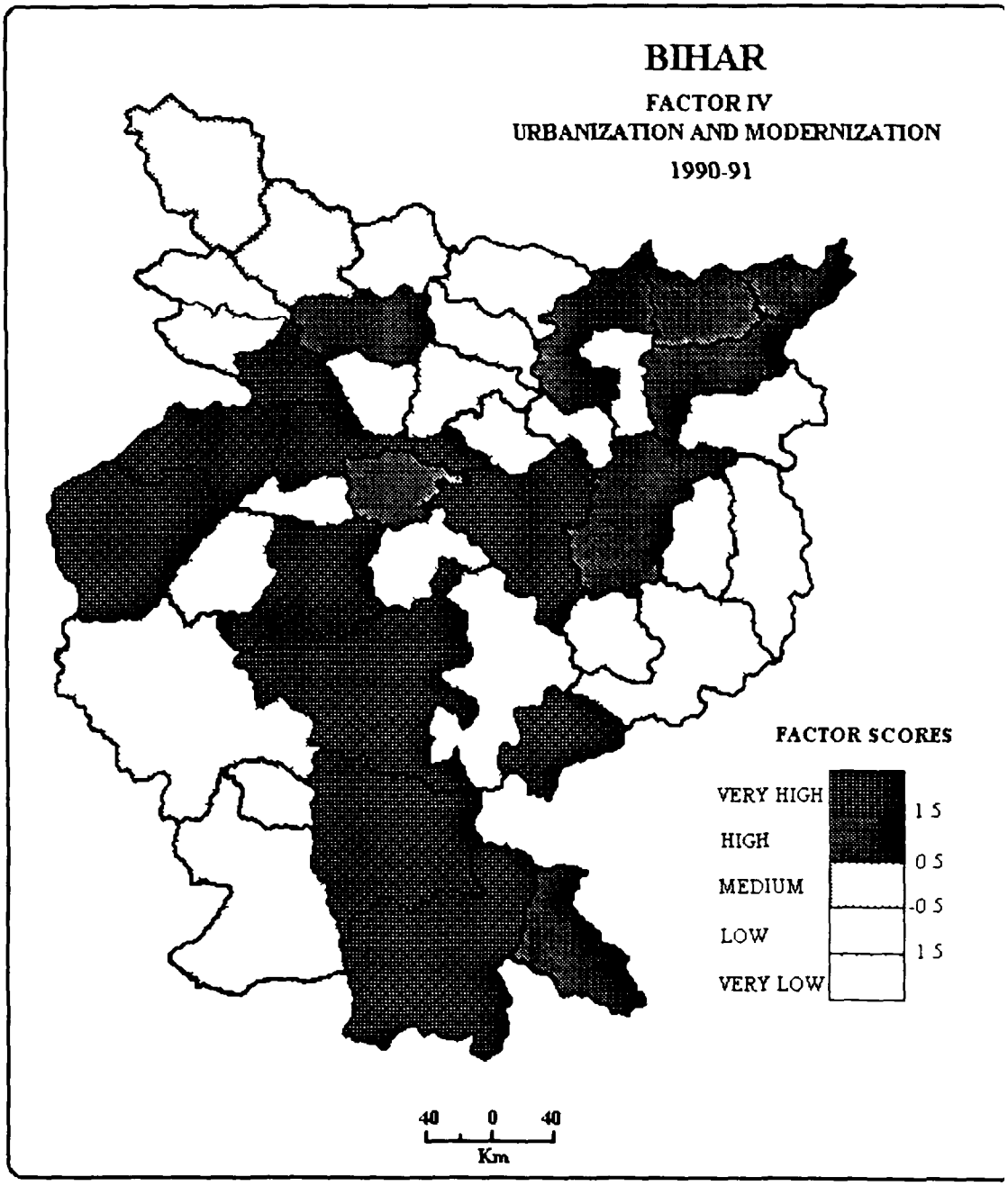

BIHAR
FACTOR IV
URBANIZATION AND MODERNIZATION
1990-91
FACTOR SCORES
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1 5
0 5
-0 5
1 5
40 0 40
Km

FIG. 26

The number of districts under medium grade of urbanization and modernization is five. They are scattered in the northern-central part of the state. It includes the district of Madhubani, Samastipur, Begusarai, Nawada and Katihar. The rest of the districts either have low or very low grade of urbanization and modernization.

In the year 1991 the number of districts under very high factor scores increased from six in 1980-81 to ten. The districts under very high factor scores form two contiguous region. One region lies in the south-central part of the state and includes the district of Gaya, Hazaribagh, Ranchi and West Singhbhum. The other region which is somewhat small includes the districts of Rohtas, Bhojpur, Saran, Patna and Munger. Dhanbad is the other district in category in south Bihar. The areas under high grade of urbanization and modernization roughly form a compact zone in the north-eastern part of the state and includes the districts of Kishanganj, Araria, Saharsa, Purnia and Bhagalpur. Apart from this there are few more districts under this category but they do not form any region. They are the districts of East Champaran, Nalanda and East Singhbhum.

It is interesting to note that there is only one district under medium grade of urbanization and modernization. Along the periphery of the state the areas are under low or very low grade of urbanization and modernization. There is contiguous region of low and very low grade of urbanization and modernization in the northern, south-western and eastern part of the state.

REFERENCES

1. Munir, A., *'Agricultural productivity and Regional Development'*, Manak Publication Pvt. Ltd. Delhi, 1992.
2. Malassis, L., *'Agriculture and Development Process, tentative guidelines for teaching, Education and Rural Development*, 3, UNESCO, Paris, 1975, PP 197-8.
3. Hanumantha, Rao, C.H., *'Farm Mechanization in a Labour Abundant Economy*, Economic and Political weekly Annual No. 1972, Vol.3, Nos. 5-7.
4. Malassis, L., *The Rural World: Education and Development*, Unesco, Paris, 1976, P.55.
5. Datt, R and Sundharam, K.P.M., *Development Issues of the Indian Economy*, New Delhi, 1979, P. 196.
6. Myrdal, G., *Asian Drama: An Inquiry into the poverty of nations*, Absidged volume, Penguin Books, London, 1972, P.248.
7. Datt and Sundharam, *op. cit*, P. 261
8. Sharma, N., *Degree of Urbanization and Level of Economic Development in Chotanagpur: A study in nature of Relationship*, Indian Journal of Regional Science, Vol. IV No.2, 1972, PP. 143-154.
9. Rao, Hemlata., *Regional Disparities and Development in India*, Delhi, 1984.
10. Singh, R.B., *Majoral Roser, (Ed.) Development issues in Marginal Regions*, New Delhi 1996.

CHAPTER 6

AGRICULTURAL PRODUCTIVITY AND REGIONAL DEVELOPMENT

After examining the regional patterns of agricultural productivity and dimensions of regional development in the study area, it would be worthwhile to study the levels of development in relation to agricultural productivity.

Regional development has been interpreted as intra-regional development designed to legitimately reduce disparities in development through planning. However, before planning, the regions lagging behind are to be demarcated and components of development are to be analysed.

Agriculture in India through it multifarious relationships has bearing on the industrial, urban, technological and social development. Agriculture itself is a system composed of multiple components and productivity measure the efficiency of the entire agricultural system. Therefore, level of agricultural productivity can safely be relied upon as a measure of development in agriculture.

Agriculture can contribute significantly to overall development as it provides increased food surplus to the growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the rural population of the region. Furthermore, agriculture's contribution in promoting overall

development can be summarised in five propositions:

(1) Agriculture must provide adequate food supplies for rapidly increasing population in the developing countries.

(2) Agricultural development is essential for supplying raw materials for the expanding industrial economy and increasing foreign exchange earnings through enlarged agricultural exports.

(3) Agriculture helps development by providing an expanded market for industry and manufactured consumer's goods.

(4) Agricultural[1] development can facilitate the development of industry by releasing labour from agriculture to non agricultural sectors.

(5) Agricultural development also brings about social and cultural development as increased per capita income in rural areas invariably results in increased literacy and level of education which are conducive for social transformation[s].

It is clear that, under all circumstances, increasing agricultural productivity makes important contribution to regional development and that, within considerable limits at least, it is one of the preconditions which must be established before a takeoff into self sustained economic growth becomes possible. It is equally clear that social and cultural change necessary to assimilate new industrial and technological development is possible through increased agricultural production.

The main objective of this chapter is to find out empirically as to what extent this theoretically postulated relationship between agricultural productivity and levels of development holds true in the case of the area under study. It would be worthwhile to test this hypothesis and to find out whether or not the high agricultural productivity regions of Bihar are well developed regions. A comparative study of agricultural productivity and levels of development will give significant results. For the purpose of this study composite indices of agricultural productivity and levels of development are constructed.

Composite Index of Agricultural Productivity

Computational Procedure

Regional patterns of the agricultural productivity in Bihar have been examined by combining two different indices of agricultural productivity. The two different indices of agricultural productivity is considered here as two variables. To obtain the composite index the equation may algebraically be expressed as follows:

$$C.I. = \frac{x.\bar{x}/\delta_1 + y.\bar{y}/\delta_2}{\bar{x}/\delta_1 + \bar{y}/\delta_2}$$

C.I. = composite index

X = represents the items in the first variable i.e. agricultural productivity based on yang's Crop yield index.

Y = represents the items in the second variable i.e. agricultural productivity based on out put per hectare of crop (in Rs.)

$\overline{X}$ = mean value of the first variable in the entire region

$\overline{Y}$ = mean value of the second variable in the entire region

δ_1 = Standard deviation of first variable

δ_2 = Standard deviation of second variable

The computed composite indices of the productivity have a wide range of variation among the districts with in the study region. The inter-districts variation may conveniently be grouped into five grades of very high, high, medium, low and very low agricultural productivity with the help of their standard deviation from the mean.

Regional Patterns (1980-81)

Very High and High Agricultural Productivity

The distributional patterns of the composite agricultural productivity for the year 1980-81 have been plotted in Fig. 27. It may be observed from the Fig. 27 that the very high agricultural productivity is found in the northern and central parts of the state. In fact the districts of very high agricultural productivity form two small regions; one lie in the north-western part of the state comprises the districts of West Champaran and East Champaran, the second lie in the central part and includes the districts of Samastipur, Begusarai, Nalanda and Patna. The areas of high agricultural productivity are generally found in the northern part of the state. The districts of high agricultural productivity do not form any significant region as they are scattered apart. The districts under high agricultural productivity are Siwan, Rohtas, Sitamarhi, Nawada, Purnia and Bhagalpur.

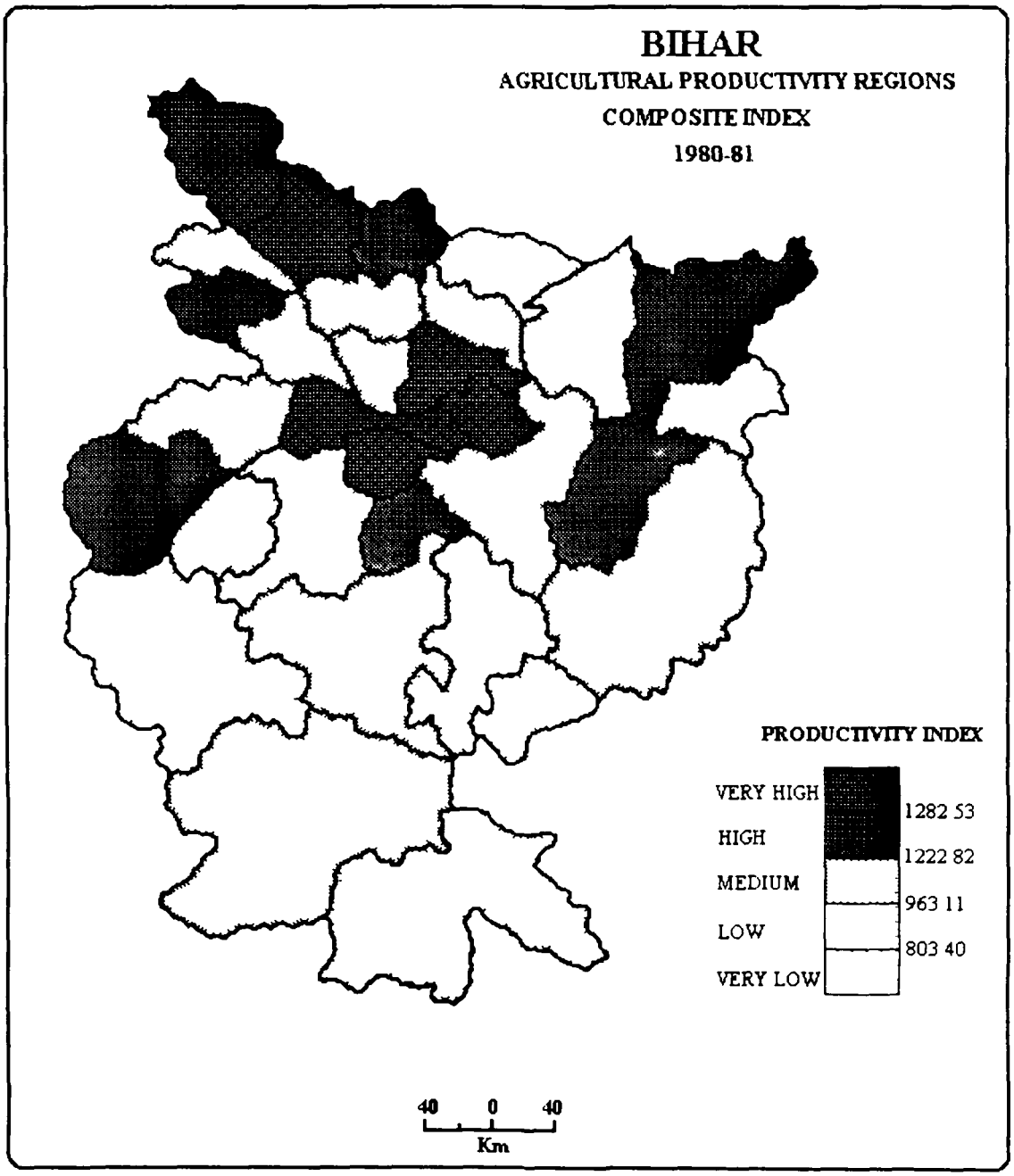

BIHAR
AGRICULTURAL PRODUCTIVITY REGIONS
COMPOSITE INDEX
1980-81
PRODUCTIVITY INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
1282 53
1222 82
963 11
803 40
40 0 40
Km

FIG. 27

Medium Agricultural Productivity

Areas under medium agricultural productivity form three contiguous regions, the first lie in the central-western part of the state and includes the districts of Gopalganj, Saran, Bhojpur, Vaishali, Muzaffarpur and Darbhanga, the second lie in the central-eastern part of the state and includes the districts of Santhal Pargana and Munger and the third lie in the southern part and includes the districts of Hazaribagh and Ranchi

Low and Very Low Agricultural Productivity

The regional distribution of agricultural productivity shows that in southern part of the state, the productivity of land is low or very low The districts having low agricultural productivity are Gaya, Aurangabad, Dhanbad, Singhbhum, Katihar, Saharsa and Madhubani, whereas the districts of Palamu and Giridih have very low agricultural productivity

Regional Patterns (1990-91)

Very High and High Agricultural Productivity

The distributional patterns of composite index of agricultural productivity for the year 1990-91 have been plotted in Fig 28 It may be observed from the Fig 28 that very high agricultural productivity form a large contiguous region in the north-western part of the state and includes the districts of West Champaran, East Champaran, Gopalganj, Siwan and Saran Apart from this there are two small regions

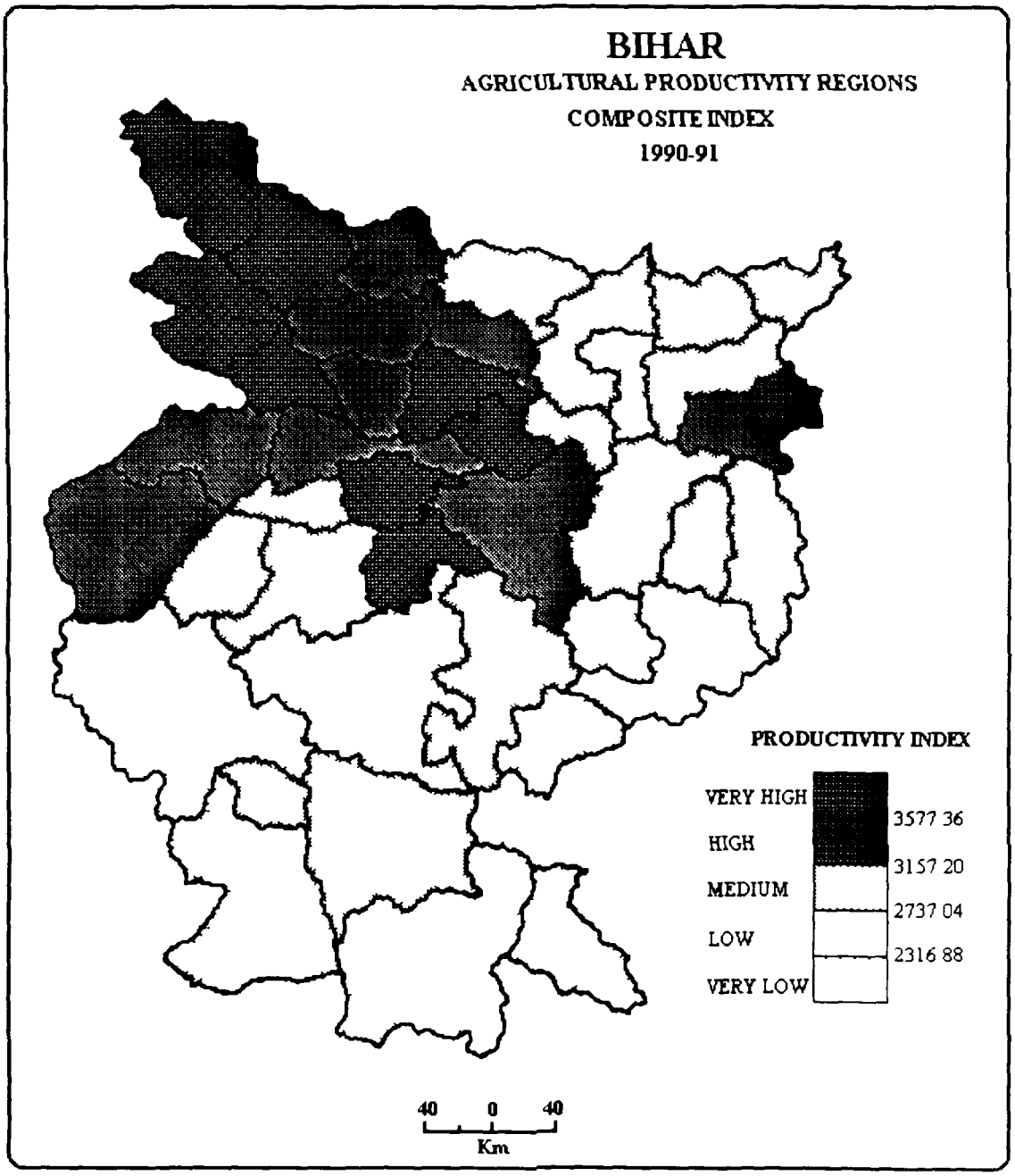

BIHAR
AGRICULTURAL PRODUCTIVITY REGIONS
COMPOSITE INDEX
1990-91
PRODUCTIVITY INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
3577 36
3157 20
2737 04
2316 88
40 0 40
Km

FIG. 28

of very high agricultural productivity in the central part of the state. It includes the districts of samastipur, Begusarai, Nalanda and Nawada.

The areas of high agricultural productivity form a large contiguous region in the central-western part of the state. The districts which form this region are Rohtas, Bhojpur, Patna, Vaishali, Muzaffarpur, Darbhanga, Sitamarhi and Munger. Katihar is the only district of high agricultural productivity which do not form any region.

Medium Agricultural Productivity

The areas of medium agricultural productivity form a large contiguous region in the north-eastern part of the state which includes the districts of Madhubani, Saharsa, Khagaria, Araria, Kishanganj, Purnia, Bhagalpur, Godda and Sahibganj. There are two small regions of medium agricultural productivity; one in the central part comprising the districts of Jehandabad, Aurangabad; and other in the southern part of the state comprising the districts of Lohardaga, Ranchi and Giridih.

Low and Very Low Agricultural Productivity

Most of the districts of the southern Bihar either have low or very low agricultural productivity. The districts of low agricultural productivity are Gumla, Hazaribagh, Dhanbad and Deoghar; whereas the districts of very low agricultural productivity are Madhepura, Dumka, Palamu, Singhbhum East and Singhbhum West.

Composite Index of the Regional Development

Computational Procedure

The composite index of the regional development is, in fact, a weighted aggregate of the five factors of development as discussed in Chapter 5. The standardized factor scores of each factor are multiplied respectively by the respective percentage of total variance which they explain. As such, each dimension of development is weighted according to its contribution to the development levels in the area. These factor scores of the four dimensions of the development are added together to give a composite index of development. (Appendices, G and H).

To obtain the composite index in order to assess the regional development, the equation may be algebraically be expressed as:

$$C.I. = \frac{X_1 \overline{X}_1/\delta_1 + X_2 \overline{X}_2/\delta_2 + X_3 \overline{X}_3/\delta_3 + \ldots\ldots\ldots\ldots X_{20} \overline{X}_{20}/\delta_{20}}{\overline{X}_1/\delta_1 + \overline{X}_2/\delta_2 + \overline{X}_3/\delta_3 + \ldots\ldots\ldots\ldots \overline{X}_{20}/\delta_{20}}$$

where C.I. = composite index

$X_1, X_2, \ldots\ldots\ldots\ldots X_{20}$ = the number of variable considered

$\overline{X}$ = the mean value of the variable in the entire region.

δ = standard deviation of each variable.

The computed composite indices of the variables have a wide range of variation among the districts of the state. The inter districts variation may conveniently be grouped into five grades of vary high, high, medium, low and very low levels of development with the help of their standard deviation from the mean.

Regional Patterns (1980-81)

Very High and High Development

The regional patterns of the levels of development for the year 1980-81 have been shown in Fig. 29. It may be observed from the Fig.29 that there are only four districts namely, Patna, Nalanda, Ranchi and Dhanbad which have very high level of development. Out of these four districts Patna and Nalanda form a very small region of very high level of development in the central part of the state but Ranchi and Dhanbad do not form any region.

The districts having high level of development are Gaya, Nawada and Singhbhum. Gaya and Nawada form a small region of high level of development in the central part of the state.

It is interesting to note that the almost all the districts of very high and high development have strong association with the dimension of mechanization of agriculture in the Central part of the state, but in the southern part of the state they do not have any association with the mechanization of agriculture. In the southern part of the state the districts of very high and high levels of development have strong association with the dimensions of infrastructural development and industrialization.

Medium Level of Development

The districts of medium level of development are concentrated in the north-western part of the state and form a small region in this part of the state. The districts of medium level of development are

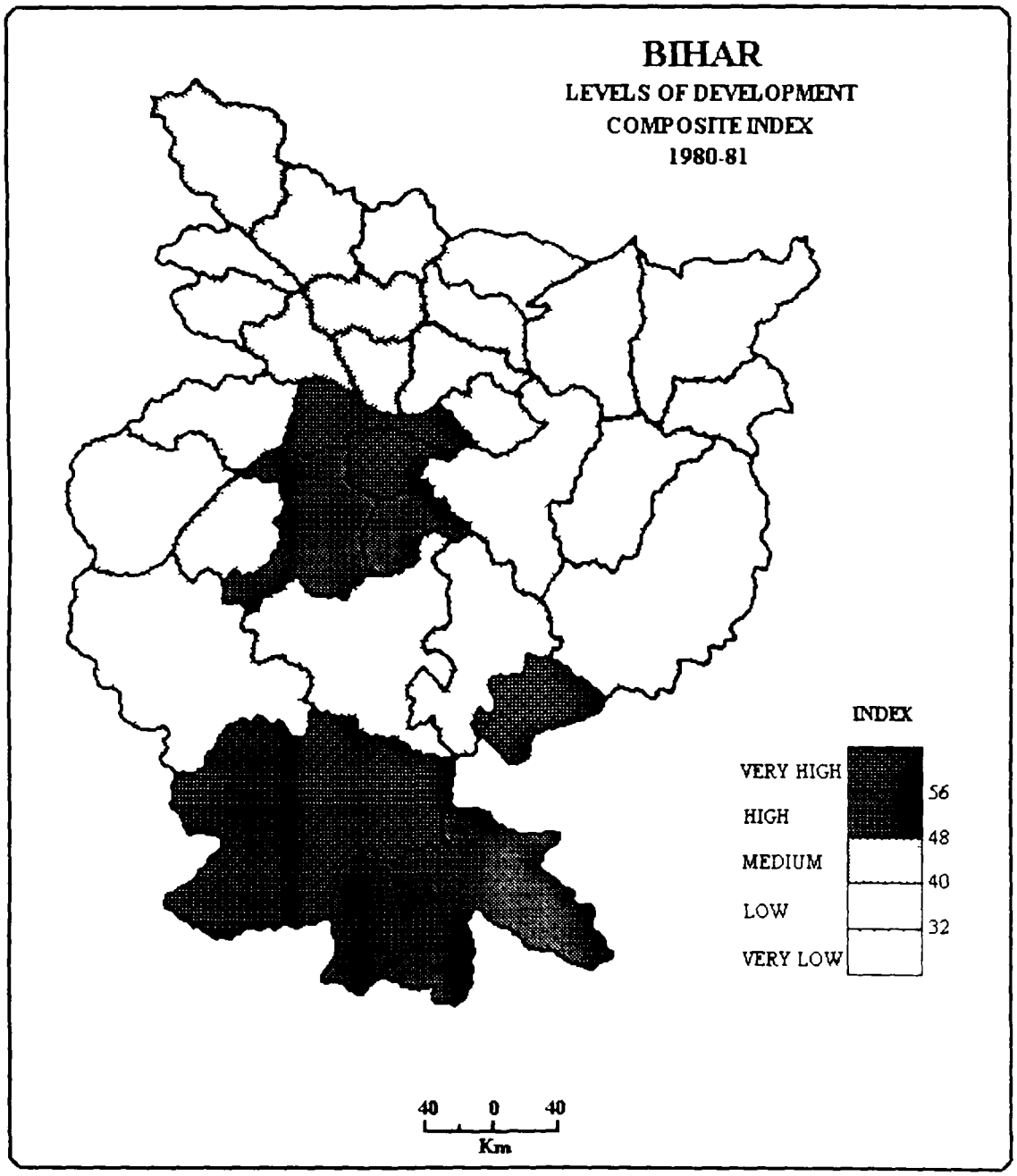

BIHAR
LEVELS OF DEVELOPMENT
COMPOSITE INDEX
1980-81
INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
56
48
40
32
40 0 40
Km

FIG. 29

Saran, Vaishali, Muzaffarpur and West Champaran The districts of medium level of development exhibit scores ranging from very high to very low on the dimensions of agricultural mechanization and education, infrastructural development and industrialization, institutional development and agricultural intensity, and urbanization and modernization However, the majority of districts score moderately on these dimensions

Low and Very Low Level of Development

The most of the districts of the study area for the year 1980-81 either have low level of development or very low level of development This indicate that the development of the state is generally low The districts having low level of development are Siwan, East Champaran, Bhojpur, Aurangabad, Darbhanga, Samastipur, Begusarai and Hazaribagh Whereas the districts having very low level of development are mainly confined to the areas of northern part of the state which is agriculturally rich as compared to southern part of the state The districts of very low level of development are Sitamarhi, Madhubani, Saharsa, Purnia, Katihar, Munger, Bhagalpur, Santhal Pargana, Giridih and Palamu

Regional Patterns (1990-91)

Very High and High Level of Development

The regional patterns of the level of development for the year 1990-91 have been plotted in the Fig 30 It may be observed from the Fig 30 that there are four districts having very high level of

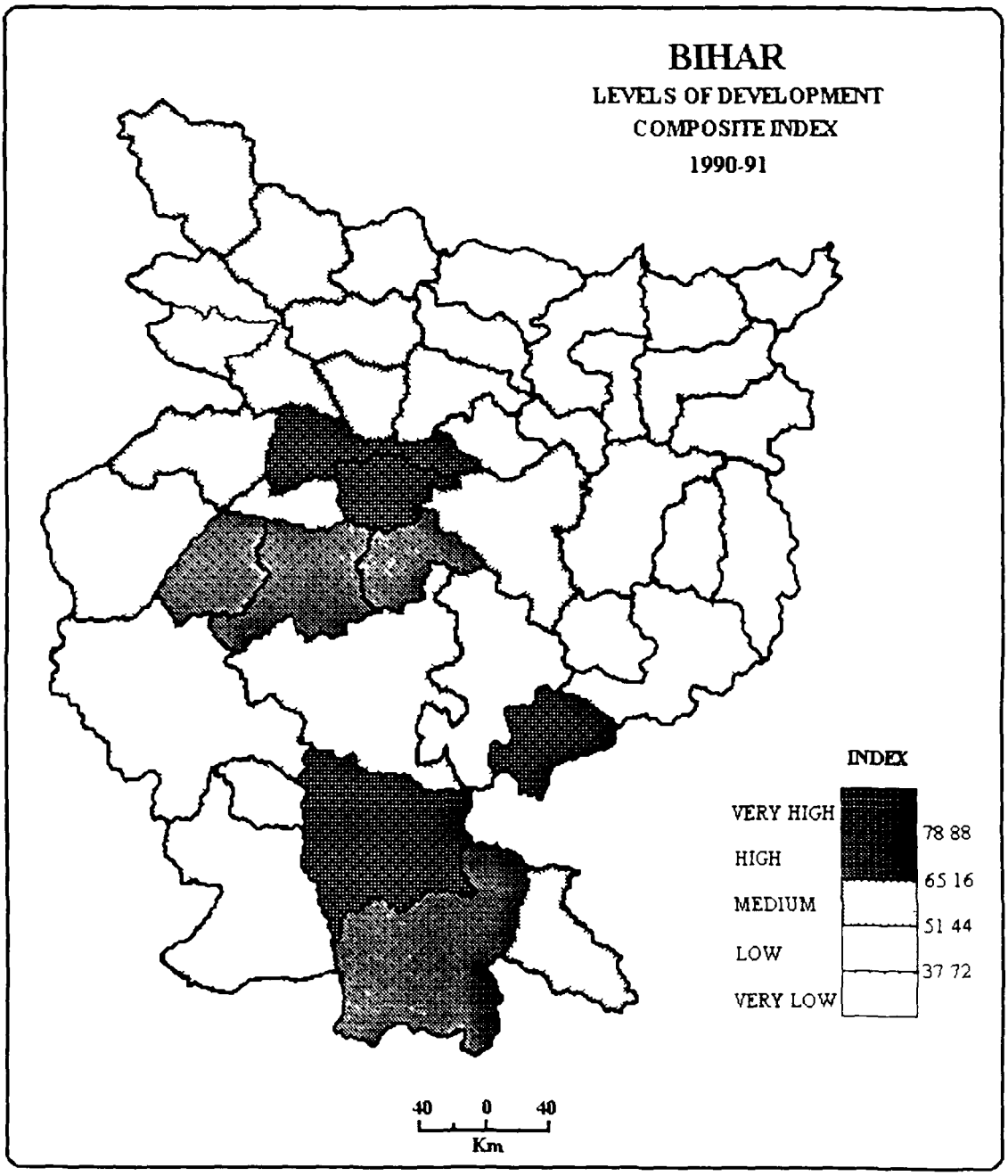

BIHAR
LEVELS OF DEVELOPMENT
COMPOSITE INDEX
1990-91
INDEX
VERY HIGH
HIGH
MEDIUM
LOW
VERY LOW
78 88
65 16
51 44
37 72
40 0 40
Km

FIG. 30

development. The districts of Patna, Nalanda, Ranchi and Dhanbad. The districts of Patna and Nalanda form a small region in the central part of the state.

The high level of development in the state includes the districts of Aurangabad, Gaya, Nawada and Singhbhum West. The districts of Aurangabad, Gaya and Nawada form a small region in the central part of the state. The distributional pattern of very high and high level of development in 1990-91 do not show any difference from the year 1980-81. In fact, the very high and high level of development for both the time periods are similar.

Medium Level of Development

The districts having medium level of development are mainly confined to north-western part of the state and form a large contiguous region including the districts of West Champaran, East Champaran, Muzaffarpur, Vaishali, Saran and Bhojpur. Apart from this the other two districts which fails to form any region are Munger and Singhbhum East. The districts of medium level of development exhibit scores ranging from very high to high on the dimension of agricultural mechanization and education and medium to very low on the dimensions of infrastructural development and industrialization; institutional development and agricultural intensity; and modernization and urbanization.

Low and Very Low Level of Development:

The low and very low level of development are found in the western, south-western, northern, north-eastern and eastern part of the state. The districts of low and very low level of development have strong association with the dimensions of institutional development and agricultural intensity; and infrastructural development and industrialization. The low scores on these dimensions of development contribute significantly to the low level of development of the state.

Relationship Between Agricultural Productivity and Regional Development in Bihar

An examination of Fig.27, Fig.28, Fig.29, Fig.30 reveals that agricultural productivity and levels of development, barring few exceptions do not coincide with each other i.e. high agricultural productivity do not have high level of development and vice versa.

Agriculture productivity and regional development for the year 1980-81 as shown in table 11 and depicted Fig.27 and Fig.29, it has been observed that the districts of West Champaran , East Champaran, Samastipur, Begusarai, Patna and Nalanda have very high agricultural productivity. Out of these six districts having very high agricultural productivity, Patna and Nalanda have very high level of development, West Champaran has medium level of development, East Champaran, Begusarai and Samastipur have low level of development. On the other hand the districts having very high level of development are Patna, Nalanda, Ranchi and Dhanbad. Out of these four districts of very high

development, Patna and Nalanda have very high agricultural productivity, Ranchi has medium agricultural productivity and Dhanbad has low agricultural productivity.

As regards high agricultural productivity there are six districts, having high agricultural productivity. They are the districts of Siwan, Purnia, Bhagalpur, Sitamarhi, Rohtas, and Nawada; out of these six districts only Nawada has high development, Siwan and Rohtas have low development and Sitamarhi, Purnia and Bhagalpur have very low level of development. On the other hand districts having high level of development are Gaya, Nawada and Singhbhum; out of these three districts Nawada has high agricultural productivity and Singhbhum and Gaya have low agricultural productivity.

The districts which have medium agricultural productivity are Saran, Vaishali, Darbhanga, Bhojpur, Muzaffarpur, Munger, Hazaribagh, Gopalganj, Ranchi and Santhal Pargana. Out of these ten districts, Ranchi has very high level of development; Saran, Vaishali and Muzaffarpur have medium level of development; Bhojpur, Hazaribagh and Darbhanga have low level of development and Munger, Santhal Pargana and Gopalganj have very low level of development. The districts which have medium level of development are West Champaran, Saran, Vaishali and Muzaffarpur. Out of these four districts having medium level of development, West Champaran has very high agriculutral productivity; Saran, Vaishali and Muzaffarpur have medium agricultural productivity.

Table 11

Agricultural Productivity and Regional Development

(Composite under 1980-81)

Grade	Name of District Under Agriculutral Productivity	No. of District Under Agricultural Productivity	Name of District Under Regional Development	No. of District Under Regional Development
Very High	West Champaran, East Champaran Samastipur, Begusarai, Patna, Nalanda	6	Patna, Nalanda, Dhanbad, Ranchi	4
High	Siwan, Purnia, Bhagalpur, Sitamarhi, Rohtas, Nawada	6	Gaya, Nawada, Singhbhum	3
Medium	Saran, Vaishali, Darbhanga Bhojpur, Muzaffar, Munger, Hazaribagh, Santhal Pargana, Gopalganj, Ranchi	10	West Champaran, Saran, Vaishali Muzaffarpur	4
Low	Madhubani, Saharsa, Katihar, Gaya, Aurangabad, Singhbhum, Dhanbad	7	Siwan, Rohtas, Aurangabad, Hazaribah, Begusarai, Samastipur, Darbhanga, Bhojpur, East Champaran	9
Very Low	Palamu, Giridih	2	Sitamarhi, Madhubani, Saharsa, Purnia Bhagalpur, Santhal Pargana, Giridih, Palamu, Gopalganj, Katihar, Munger	11

The districts of Madhubani, Saharsa, Katihar, Aurangabad, Gaya, Singhbhum and Dhanbad have low Agricultural productivity, Out of these seven districts of low agricultural productivity Dhanbad has very high level of development; Gaya and Singhbhum have high level of development and Madhubani, Katihar and Saharsa have very low level of development. Contrary to this, the districts having low level of development are Siwan, Rohtas, Aurangabad, Hazaribagh, Begusarai, Samastipur, Darbhanga, Bhojpur and East Champaran. Out of these nine districts of low development, East Champaran, Samastipur and Begusarai have very high agricultural productivity; Siwan and Rohtas have high agricultural productivity; Bhojpur, Hazaribagh and Darbhanga have medium agricultural productivity, and Aurangabad has low agricultural productivity.

There are two districts having very low agricultural productivity. They are the districts of Palamu and Giridih. Both Palamu and Giridih have very low level of development. On the other hand there are eleven districts having very low level of development. They are the districts of Sitamarhi, Madhubani, Saharsa, Purnia, Bhagalpur, Santhal pargana, Giridih, Palamu, Gopalganj, Katihar and Munger. Out of these eleven districts, Purnia, Bhagalpur and Sitamarhi have high agricultural productivity; Munger Gopalganj and Santhal Pargana have medium agricultural productivity; Katihar, Saharsa and Madhubani have low agricultural productivity and Giridih and Palamu have very low agricultural productivity.

Again examination of Fig.28, Fig.30 and Table 12 reveals that high agricultural productivity are not associated with higher levels of development and vice versa. Agricultural productivity and regional development for the year 1990-91 as depicted in the Fig.28, and Fig.30, it has been observed that the districts having very high agricultural productivity are Siwan, Gopalganj, Nawada, West Champaran, Saran, Nalanda, Samastipur, Begusarai and East Champaran. Out of these nine districts Nalanda has very high development; Nawada has high level of development; West Champaran, East Champaran and Saran have medium level of development; Siwan, Gopalganj and Samastipur have low level of development and Begusarai has very low level of development. Whereas, the districts having very high level of development are Patna, Nalanda, Dhanbad and Ranchi. Out of these four districts Nalanda has very high agricultural productivity; Patna has high agricultural productivity; Ranchi has medium agricultural productivity and Dhanbad has low agricultural productivity.

For the year 1990-91 the districts having high agricultural productivity are Sitamarhi, Munger, Muzaffarpur, Rohtas, Darbhanga, Vaishali, Patna, Bhojpur and Katihar. Out of these nine districts Patna has very high level of development; Vaishali, Munger, Bhojpur and Muzaffarpur have medium level of development; Sitamarhi, Darbhanga Rohtas and Katihar have low level of development. On the other hand, districts having high level of development are Nawada, Singhbhum West, Aurangabad and Gaya. Out of these four districts Nawada has

Table 12

Agricultural Productivity and Regional Development in Bihar

(Composite Index 1990-91)

Grade	Name of District Under Agriculutral Productivity	No. of District Under Agricultural Productivity	Name of District Under Regional Development	No. of District Under Regional Development
Very High	Siwan, Gopalganj, Nawada, Saran, Nalanda, Samastipur, Begusarai, East Champaran	9	Patna, Nalanda, Dhanbad, Ranchi	4
High	Sitamarhi, Munger, Muzaffarpur, Rohtas, Darbhanga, Vaishali, Patna, Bhojpur, Katihar	9	Nawada, Singhbhum West, Aurangabad, Gaya	4
Medium	Madhubani, Saharsa, Araria, Kishanganj, Purnia, Khagaria, Bhagalpur, Sahibganj, Lohardagga, Aurangabad, Jehanabad, Gaya, Ranchi, Godda, Giridih	15	West Champaran, East Champaran Saran, Vaishali, Munger, Bhojpur, Muzaffarpur, Singhbhum East	8
Low	Hazaribagh, Dhanbad, Deoghar, Gumla	4	Siwan, Gopalganj, Sitamarhi, Saharsa, Katihar, Bhagalpur, Hazaribagh, Jehanabad, Samastipur, Rotas, Darbhanga, Purnia	12
Very Low	Palamu, Singhbhum West, Singhbhum East, Medhepura Dumka	5	Begusarai, Khagaria, Kishanganj, Godda, Medhepura, Sabhiganj, Dumka, DeogharGumla, Lohardaga, Palamu, Araria, Giridih, Madhubani	14

very high agricultural productivity; Aurangabad and Gaya have medium agricultural productivity and Singhbhum West has very low agricultural productivity.

As regards medium agricultural productivity there are fifteen districts which have medium agricultural productivity. They are Madhubani, Saharsa, Araria, Kishanganj, Purnia, Khagaria, Bhagalpur, Sahibganj, Lohardaga, Aurangabad, Jehanabad, Gaya, Ranchi, Godda and Giridih. Out of these fifteen districts Ranchi has very high level of development; Gaya and Aurangabad have high level of development; Saharsa, Purnia, Bhagalpur and Jehanabad have low level of development; and Khagaria, Sahibganj, Lohardaga, Giridih, Madhubani, Godda, Araria and Kishanganj have very low level of development. On the other hand districts having medium level of development are West Champaran, East Champaran, Saran, Vaishali, Munger, Bhojpur, Muzaffarpur and Singhbhum East. Out of these eight districts of medium level of development, West Champaran, East Champaran and Saran have very high agricultural productivity; Munger, Vaishali, Muzaffarpur, and Bhojpur have high agricultural productivity and Singhbhum East has very low agricultural productivity.

The districts of Hazaribagh, Dhanbad, Deoghar and Gumla have low agricultural productivity. Out of these four districts Dhanbad has very high level of development;

Hazaribagh has low level of development and Gumla and Deoghar have very low level of development. On the other hand, the districts having low level of development are Siwan, Gopalganj, Sitamarhi, Saharsa, Katihar, Bhagalpur, Hazaribagh, Jehanabad, Samastipur, Rohtas, Darbhanga and Purnia. Out of these twelve districts Gopalganj, Siwan and Samastipur have very high agricultural productivity; Sitamarhi, Katihar, Rohtas and Darbhanga have high agricultural productivity; Saharsa, Bhagalpur, Purnia and Jehanabad have medium agricultural productivity; and Hazaribagh has low agricultural productivity.

There are five districts having very low agricultural productivity. They are the districts of Palamu, Singhbhum West, Singhbhum East, Medhepura and Dumka. Out of these five districts, Singhbhum West has high level of development; Singhbhum East has medium level of development; and Palamu, Medhepura and Dumka have very low level of development.

In order to analyse the relationship between agricultural productivity and levels of development two scatter diagrams have been constructed as shown in Fig.31 and Fig.32 for the years 1980-81 and 1990-91 respectively. The X-axis of the scatter diagram represent agricultural productivity and Y-axis the levels of development. Vertical and horizontal lines demarcating the different levels of agricultural productivity and levels of development are drawn for the ease of analysis.

An examination of Fig.31 reveals that there are two districts having very low agricultural productivity and very low level of development. There are seven districts having low agricultural productivity. Out of these seven districts, three districts have very low level of development, one district has low level of development, two districts have high level of development and one district has very high level of development. With regards to the districts showing medium agricultural productivity, three districts have very low level of development, three districts have low level of development, three districts have medium level of development and one district has very high level of development. There are six districts showing high agricultural productivity. Out of six districts having high agricultural productivity, three districts have very low level of development; two districts have low level of development and one district has high level of development. Again there are six districts having very high agricultural productivity. Out of these six districts, three districts have low level of development, one districts has medium level of development and two districts have very high level of development.

Again an examination of Fig.32 reveals that in the year 1990-91 there are five districts having very low agricultural productivity, three districts have very low level of development, one district has medium level of development and one district has high level of development. There are only four districts having low agricultural productivity, among which two districts

BIHAR

SCATTER DIAGRAM: RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTIVITY AND LEVELS OF DEVELOPMENT 1980-81

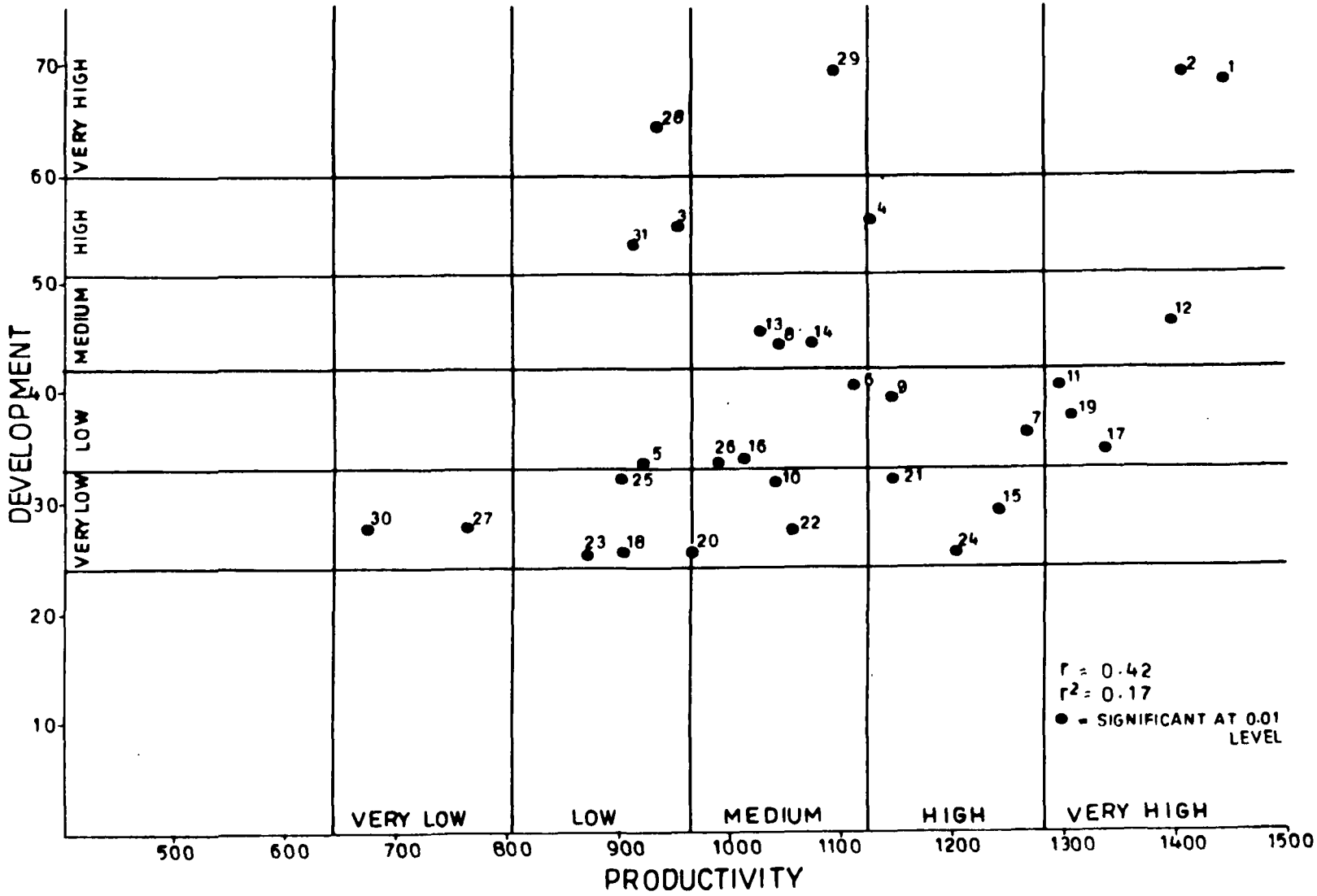


Fig. 31

BIHAR

SCATTER DIAGRAM: RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTIVITY AND LEVELS OF DEVELOPMENT 1990-91

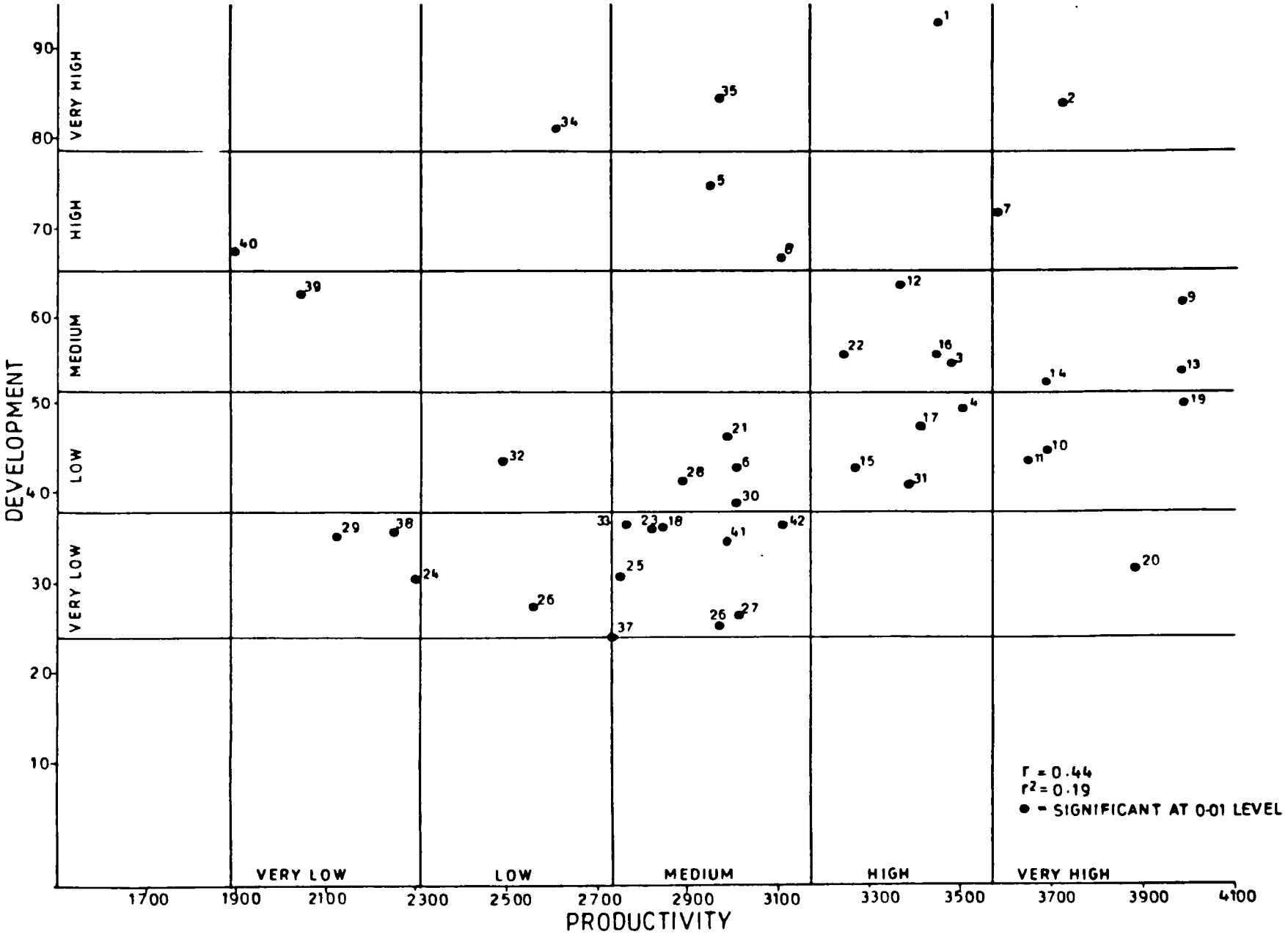


Fig. 32

have very low level of development, one districts has low level of development and one district has very high level of development. As regards medium agricultural productivity there are fifteen districts. Out of these fifteen districts having medium agricultural productivity eight districts have very low level of development, four districts have low level of development, two districts have high level of development and one district has very high level of development. Nine districts have high agricultural productivity, out of which four districts have low level of development, four districts have medium level of development and one district has very high level of development. Again there are nine districts having very high agricultural productivity, one district has very low level of development, three districts have low level of development, three districts have medium level of development, one districts has high level of development and one district has very high level of development.

In general, it is observed that there is weak positive correlation between agricultural productivity and levels of development on the scatter diagrams. To accertain this relationship product moment correlation is workout. The coefficient of correlation (r) turns up as low as 0.42 and 0.44 for the year 1980-81 and 1990-91 respectively. This is significant at 99 percent level of confidence. To find the amount of variance in the level of development explained by the agricultural productivity, coefficient of determination (r^2) is computed which is 0.17 and 0.19 i.e. about 17 and 19 percent spatial variation in the levels of development is due to variation in agricultural productivity

for the year 1980-81 and 1990-91 respectively.

The findings of this analysis do not verify our hypothesis that the agricultural productivity in Bihar is a component of regional development. That is, higher levels of development are not associated with the higher levels of agricultural productivity and vice versa. The overwhelming importance of agriculture in Bihar's economy cannot be over emphasized but agricultural productivity in Bihar, the study area, appears to be less significant or weak factor of urbanization, industrialization, infrastructural an social development. In fact, agriculture do not provide the resource base for urbanization and modernization. The ever increasing population is exerting a great pressure on land and adversely affecting the man land ratio. As agriculture is of intensive subsistence type, farmers grows a large variety of crops and production is just sufficient to maintain their families, only a small surplus in marketed locally to buy agriculutral implements and other necessary items for their domestic use.

The per hectare yield is comparatively low in Bihar. It is barely one third or one fourth of the yield of the agriculturally advance states of India. The low yield per hectare has a direct influence upon the health, efficiency and nutritional standard of rural inhabitants. The low yield per hectare in the study area is due to less and improper utilization of land and modern agricultural inputs.

The over all agricultural productivity of Bihar is generally low but in northern and central Bihar, where agriculture is the only

occupation of the majority of population, agricultural productivity is comparatively high as compared to southern Bihar. This is due to the high fertility of soil, better irrigation facilities and due to diffusion of modern inputs in some parts of northern and central Bihar. Inspite of high agricultural productivity the regional development in the area is very slow. This may be due to high growth of population which leads to the low investment in the agricultural sector. The extra production being consumed by extra population. Contrary to this, the southern Bihar plateau, which is the store house of large number of minerals, both mining and agriculture are the main occupation of the people. The agricultural productivity is generally low as compared to northern and central Bihar. The soil layer of southern Bihar is thin and lies over a rocky stratum and therefore it become burnt during dry season resulting in low productivity. Besides, the topography of southern Bihar plateau is not suitable for growing all types of crops which is important to support large population of the area. As the agricultural productivity is generally low in Southern Bihar it do not contribute to regional development of region.

It is generally found that the agricultural productivity as a measure of efficiency of agricultural system through various links has a strong bearing on the level of development, but in Bihar, the area under study, the agricultural productivity as a component of regional development has a weak or no bearing on the level of regional development.

CONCLUSION AND SUGGESTIONS

The over all analysis of the study reveals the fact that there is a inverse relationship between agricultural productivity and level of regional development in Bihar. That is higher levels of development are not associated with the higher levels of agricultural productivity and vice versa. Negligence of agricultural sector in Bihar's planning, lack of irrigation facilities, obsolete method of farming, indebtedness and illiteracy among farmers, nominal use of HYV of seeds, meagre amount of chemical fertilizers and pesticides, lack of land tenure system based on social justice and lack of credit facilities have all combined to put agriculture and consequent regional development in low key in Bihar. It is unfortunate that major portion of agricultural land is still owned by privileged castes/classes of the society who are not only inexperienced cultivator but very often act as petty neo-*Zamidars* employing landless labourers for paltry wages and pocket the major share of produce. The urbanites in many cases earn, while earning their livelihood in the cities may simultaneously own land in the villages, and enjoy the benefits of neo-feudal system.

In North Bihar plain where per hectare production is comparatively higher the socio-economic standard of population has been recorded low while the reverse is true in case of Chotanagpur plateau. It may have been due to the nature of occupational structure of population and variations in levels of sectoral development of economy in the two major regions of Bihar. Agriculture is the mainstay

of population in northern Bihar where intensive subsistence agriculture is in practice in which all working members get employment in the agricultural peak season and remain without job in the agriculture slack season. The production in North Bihar is relatively higher due to alluvial soils deposited by the rivers in their flood plains in monsoon season. Therefore, in the *rabi* season farmers generally get good returns inspite of low level of inputs. But their socio-economic status remain low due to high density of population, lack of secondary economic activities, very low level of per-capita production and devastating floods nearly in every monsoon season in which millions of people are rendered homeless and these flood cause great loss of life and property. In the southern part of Bihar, the soils are thin due to hard rocks, less fertile and in undulating and rugged topography the rainfall is less effective and it is very difficult to develop the means of irrigation. The tribal population that dominates in rural areas practice subsistence agriculture and do not like to use modern techniques of agriculture and they generally produce the coarse grains. Consequently, agricultural productivity is low in Chotanagpur plateau as compared to Northern Bihar plain. But, the level of socio economic status of population is high. It has been due to development of infrastructural facilities caused by large scale mining and metallurgical industries that attract a number of migrants in the form of engineers, technicians, and skilled and semiskilled labourers from various part of the country and also from abroad. It is a fact that the socio-economic status of the population engaged in secondary and tertiary economic activities is generally high, though the level of agricultural productivity may be low in particular

region.

For long, electricity generation in Bihar has remained grossly inadequate; electricity is also high priced. In consequence, though the aluminium industry in the country depends on Bihar for high grade bauxite ore, the units are located outside the state. Among the many factors which have hindered Bihar's economic progress, the lack of an adequate road system has been one of the most important. The quality of the surfaced roads in the State has not also been satisfactory as a large proportion of the road suffers from narrow width and inadequate facilities for two way traffic.

The following strategies may be adopted to develop agriculture and minimize the inequalities in the level of regional development in Bihar.

The consumption of modern in puts as high yielding varieties of seeds, chemical fertilizers, insecticides and pesticides, and use of biofertilizers is very low in Bihar. The financial position of farmers is also very poor so they are not in position to use these inputs in agriculture on a large scale. Therefore, government has to provide these inputs to farmers on a subsidized rates and train them to utilize them. By modern inputs the agricultural productivity cannot be increased until water is provided by assured irrigation. In North Bihar plain the devastating floods bring a great havoc in every monsoon season. Constructing dams and reservoirs on these rivers on the one hand the devastation by floods may be controlled on a large extent

and on the other hand by the construction of canals the water may be provided to the farmers in the dry season. Moreover, by generating hydroelectricity from these dams the electricity may be provided to the farmers to operate their tube wells and small scale agro-based and cottage industries.

The labourers in rural areas get employment in agricultural peak season and generally they remain without job during long agricultural slack season. Therefore, they are forced to migrate to the various parts of country. It may be observed, that the trains connecting north Bihar plain to the Punjab, Haryana, Western Uttar Pradesh, Maharashtra, Gujrat and various other industrial centres, these trains are generally over crowded by the agricultural labourers from Bihar. Thousands of them travel in these trains by sitting on the roofs of the compartment and in railway jerkings a number of them are died. If the small scale agro-based industries as sugarcane, oil, floor, pulse and rice mills are developed in rural areas it will not only provide jobs to redundant agriculture labourers in agricultural slack season but will also on a large extent neutralize the cause of their outmigration to other states where they face a number of problems and also increases the problems of government and workers in these states.

The Bihar is the State in India where the literacy rate in 1991 census has been recorded the lowest. Therefore due to illiteracy and ignorance the farmers spend money on superstitions and traditions and do not have the money to invest in agriculture. They also do not have access in financial institution to get loans and subsidies. Therefore,

any plans of agriculture and other development may not bring the required results until the rural population is educated and the farmers are trained to develop agriculture and to avail the facilities provided by government to develop agriculture and raise their socio-economic status.

New land reform should be intacted either to restore land to the actual tiller or manage the same field through State/cooperatives to improve the conditions of agriculture in the region so that agricultural productivity and the development in true sense may be achieved.

The physical as well as cultural environment of Bihar is most varied. In view of local variation on physical conditions and uneven distribution of the components of modern agricultural technology, it is not possible to put any single plan of agricultural transformation of Bihar as a whole. Because a plan suitable for one region may be quite unsuitable for others. As the overall analysis of the present study reveals the fact that there is underdevelopment of agriculture and regional development in most of the areas of the State, cause by spatial variation in terrain and socio-economic status of population. Therefore, it is the need of hour to increase the agricultural productivity of various crops for feeding teeming millions of population by diffusion of green revolution technology in interior backward area of the state. It may be possible when the state is divided into various micro agro-climatic zones and establishing agricultural research institute in each zone where high yielding varieties of seeds of crops have to be developed, suited

for a particular agro-climatic region after considering the cultural background of the population.

Chotanagpur plateau is the store house of the minerals where a number of ferrous and nonferrous minerals are found in a very small area. The industries based on these minerals have been develop in various parts of the country by the government for bringing regional equilibrium in industrial development of the country.

In most of these industries the unskilled and low paid workers are from Bihar. These workers are inhumanly treated. It is a great injustice that the minerals are transported from Bihar to other states and the poor workers who have the claim over these minerals are running behind to get jobs in those industries where they are used. The recent political instability in the form of Jharkhand movement and various naxilites groups has been due to injustice to them related to the royalty of minerals and their utilization outside the state of Bihar. If you want to develop the Southern Bihar and to provide jobs to the unemployed redundant labourers it may be recommended that processing of the minerals have to be done in the area where they mined and most of metallurgical industries based on Chotanagpur plateau have to be established in various parts of the Bihar, considering the geographical factors and the level of the socio-economic status of population. The most of the job in these industries have to be provided to the native population according to their educational level and technical knowledge.

The topography of southern Bihar is rugged and undulating where inspite of high rainfall there remains scarcity of water throughout the whole

year because rainwater is drained out very soon and it cannot percolate on a large extent as underground water due to hard nature of rocks. However, this water may be stored in reservoirs on very low investment of money and may be used during dry seasons.

The tribal population that dominates in Southern Bihar is having low literacy as compared to the rural population of north Bihar. Therefore, there is need of persistent efforts by government and NGOs. to raise the literacy level of tribal population and to diffuse inputs and technology of green revolution in the remote backward area of Southern Bihar. As, it has been pointed out in the beginning that level of socio-economic development is higher in Southern Bihar as compared to Northern Bihar, but if we compare only the population engaged in agriculture then level of regional development in Southern Bihar is much low because various civic and infrastructural facilities are mainly concentrated in the urban areas and they are totally under the clutches of the people, engaged in secondary and tertiary economic activities. Therefore, it is the need of the hour that specific programmes have to be launched to develop the rural tribal population so that this section of the population may be brought into the mainstream of the nation.

As a consequence of these steps there would be overall development of the region in which agricultural as well as the industrial sector of the regional economy will develop and prosper simultaneously. The incomes obtained from the development of industrial sector should be used on education, health facilities and leisure resulting in social as well as cultural development.

However, nothing could be achieved and above mentioned remedial measures will remain ineffective until the exponential growth of population is checked.

GLOSSARY

Tarai	A belt of marshy ground and vegetation on lower parts of alluvial fan.
Dun	Longitudinal intermontane valley.
Tal	Local term given to the lakes which owe their origin to fluvial action.
Pat	Little plateau with steep sides.
Doab	Land between two rivers.
Kharif	Season of summer crops i.e. mid June to October.
Ravi	Season of winter crops i.e. November to April.
Zaid	An additional rabi crop, sown about April, May and harvested in June, July - usually melons or cucumbers.
Arhar	Pigeon Pea.
Regur	Black cotton soil.
Bhangar	Older alluvium.
Khadar	Newer alluvium.
Loo	Hot westerly wind.
Zamindar	Landlord.
Masoor	Lentil.
Moong	Green gram.
Kankar	Caalcareous nodules.
Ankron Mein	In statistics.

BIBLIOGRAPHY

Books

Agarwal. A.N., Indian Agriculture: Problem, Prospects and Progress, New Delhi, 1980.

Agarwal, A.N., (Ed.) Indian Agriculture and its Problems, New Delhi, 1953.

Agarwal, R.R., Soil Fertility in India, Bombay, 1965.

Ahmad, E., Bihar, A Physical, Economic and Regional Geography, Ranchi, 1965.

Anderson, J.R., A Geography of Agriculture, Iowa: W.M.C. Brown Co., 1970.

Amani. K.Z., Agricultural Land Use in Aligarh District, Aligarh, 1976.

Anster, V, The Economic Development of India, New York, 1957.

Bansil, P.C., Agricultural Problems of India, New Delhi: Vikas, 1977.

Barke, M. and O'Hare, G., The Third World: Diversity, Change and Interdependence, Edinburg, 1984.

Bater, W.N., Mechanization of Tropical Agriculture, London, 1957.

Basu, D.N. and Guha, G.S., Agro-climatic regional Planning in India concept Publishing Company, New Delhi, 1996.

Bergmann, I., Mechanization of Indian Farming, Popular Prakashan, Bombay, 1978.

Bhatia, B.M., Poverty, Agriculture and Economic Growth, New Delhi: Vikas, 1977.

Bhalla, G.S., Performance of Indian Agriculture, New Delhi, 1979.

Bhat, L.S., Strategy for Integrated Area Development Concept Publishing Company, New Delhi, 1988.

Brookfield, H., Interdependent Development, London, 1975.

Chisholar, M., Modern World Development: A Geographical Perspective, London, 1982.

Chowdhry, P.C. Ray, Inside Bihar, Calcutta, 1962.

Clark, C., Economics of Subsistence Agriculture, London, 1970.

Cole, J., Development and Underdevelcpment: A Profile of third World, London, 1987.

Dasgupta, B., The New Agrarian Technology and India, New Delhi, 1980.

Datt, and Sundharam, K.P.M., Development Issues of the Indian Economy, New Delhi, 1979.

Desai, R.G., Farmers, Societies and Agricultural Development.
Chugh Publications, Allahabad, 1987.

Dewan, M.L., Agriculture and Rural Development in India, New Delhi, 1982.

Dewett, K.K. and Singh, G., Indian Economics, Delhi, 1966.

Dutta, L.N., Agricultural Production Efficiency and Far Size, Universal Publishing Company Ranchi, 1997.

Elinne, G., Studies in Indian Agriculture, Bombay, 1968.

Elienne, G., India's Changing Rural Scene, Oxford University Press, 1982.

Farmer, B.H., Agricultural Colonization in India Since Independence, Delhi, 1974.

Frankel. E.R., India's Green Revolution: Political Costs of Economic Growth, Princeton University Press, 1971.

Friedmann, J., Regional Development Policy: A Case Study of Venezuela, London, 1966.

Ganguli, B.N., Trends of Agriculture and Population in Ganges Valley, London, 1938.

Godkary, D.A., Mechanized Cultivation in India, Delhi, 1957.

Govind, N., Regional Perspectives in Agricultural Development Concept Publishing Company, New Delhi, 1986.

Gopalan, C., Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad, 1980.

Griffin, Keith B., The Political Economy of Agrarian Change: An Essay on the Green Revolutions, Havard University Press, 1974.

Harris, J. (Ed.), Rural Development: Theories of Peasant Economy and Agrarian Change, London, 1982.

Hanumantha Rao, C.H., Technological Change and distribution of Grains in Indian Agriculture, The Mac Million Publishing Co., New Delhi, 1975.

Heredero, J.M., Rural Development and Social Change, New Delhi, 1977.

Hewitt de Alcantara, C., Modernizing Mexican Agriculture: Socio-Economic Implications of Technological Change, 1940-1970, Geneva 1976.

Hodder, B.W., Economic Development in the Tropics, London, 1968.

Hunter, G., Modernizing Peasant Societies, Oxford University Press, London, 1969.

I.C.A.R., Mechanical Cultivation in India, New Delhi, 1957.

I.C.A.R., Indigenous Agricultural Implements of India, New Delhi, 1960.

I.C.S.S.R., Alternatives in Agricultural Developments, New Delhi, 1980.

Jain, S.C. (Ed.), Technological Changes and their Diffusion in Agriculture, Changing Indian Agriculture, Bombay, 1966.

Jain, S.C., Problems of Agricultural Development in India, Bombay, 1967.

Jaiswal, K.S., Agricultural Technology and Fertilizer Development, Chugh Publications, Allahabad, 1997.

Jha, U.M., Irrigation and Agricultural Development, New Delhi, 1984.

Joshi. P.C., Reflection on Technological Possibilities of Peasant Agriculture, Delhi, 1973.

Kallur, M.S., Irrigation and Economic Development. Chugh Publications. Allahabad, 1987.

Kendrew, W.G., The Climate of Continents, Oxford, 1961.

Kent, N.L., Technology of Cereals, with Special Reference to Wheat, Oxford, 1975.

Krishna, D., The New Agricultural Strategy, Delhi, 1971.

Krishnan, M.S., Geology of India and Burma, Madras, 1960.

Lakshmikanthamma, S., Sustainability of Dryland Agriculture in India, M.D. Publication, New Delhi, 1997.

Lekhi, R.K., Agricultural Development in India, New Delhi, 1986.

Levis, W.A., Theory of Economic Growth, London, 1955.

Mabogunje, A.L., The Development Process: A Spatial Perspective, London, 1980.

Mandelbaum, K., The Industrialization of Backward Areas, Oxford, 1955.

Misra, G.P., Dynamics of Rural Development in Village India, New Delhi, 1982.

Misra, R.P. and Sundaram, K.V., Rural Area Development: Perspectives and Approaches; New Delhi, 1979.

Misra, R.P., (Ed.), Regional Planning, Mysore, 1969.

Mitra, A., Levels of Regional Development in India, Census of India, 1961, Vol.I, Part-I-A (i), 1965.

Morgan, W.B., Munton, R.J.C., Agricultural Geography, London, 1971.

Munir, A., Agricultural Productivity and Regional Development, New Delhi, 1992.

Mutalik Desai, V.R. (Ed.), The Strategy of Food and Agriculture in India, Bombay, 1969.

Myrdal, G., Rech, Lands and Poor, New York, 1957.

Myrdal, G., Asian Drama: An Enquiry into the Poverty of Nations, Abridged Volume, Penguin Books, London, 1972.

Mohammad, A. (Ed.), Dynamics of Agricultural Development in India, Concept Publishing Company, New Delhi, 1979.

Mohammad, N., (Ed.), Perspective in Agricultural Geography, Vol.-1 to 5, New Delhi, 1981.

Nair, K.N.S., Technological Change in Agriculture, New Delhi, 1980.

Nutly, L., The Green Revolution in West Pakistan: Implication of Technological Change, New York, 1972.

Pal, M.N., Regional Disparities in the Level of Development in India, Fifth Economic Conference, New Delhi, 1965.

Pandeya, P.C., Agriculture Planning in a Bacward Economy, Chugh Publications, Allahabad, 1987.

Pearse, A., Seeds of Plenty, Seeds of Want: Social and Economic Implications of Green Revolution, Oxford, 1980.

Pedelaborde, P., The Monsoon, translated by Clagg, M.J., London, 1963.

Planning Commission, Government of India, Resource Development Regions and Divisions of India, New Delhi, 1964.

Pandey, M.P., The Impact of Irrigation on Rural Development, New Delhi, 1979.

Pandey, R.K., Agricultural Indebtedness and Institutional Finance, New Delhi, 1985.

Pandit, S.N., Critical Study of Agricultural Productivity in Uttar Pradesh - 1951-75, Delhi, 1983.

Parthasarathy, G., Agricultural Development and Small Farmers, Delhi, 1971.

Pant, Y.P., Agricultural Development in Nepal, Bombay, 1969.

Pohekar, G.S., Studies in Green Revolution, Bombay, 1970.

Quraishi, M.A., Indian Agriculture and Rural Development, Delhi, 1985.

Raju, V.T., Impact of New Agricultural Technology on Farm Income Distribution, New Delhi, 1982.

Ram, M., High Yielding Varieties of Crops, Bombay, 1979.

Ramamurti, V., Indian Agriculture, New Delhi.

Ramaiah, P., Issues in Tribal Development Chugh Publication, Allahabad, 1987.

Ramiah, P.V., and Srivastava, Agricultural Implement of Indian Farmers, New Delhi, 1954.

Randhawa, M.S., Agricultural Research in India, New Delhi, 1963.

Rao, M.S.V.R., Soil Conservation in India, New Delhi, 1962.

Raza, M., Development and Ecology, Jaipur, 1992.

Robinson, H.D. (Ed.), Freams's Elements of Agriculture, London, 1972.

Roy, P., and Fliegel, F.C., Agricultural Innovation Among Indian farmers, National Institute of Community, Hyderabad, 1968.

Sadhu, A.N. and Amarjit, S., New Agricultural Strategy: Its Implications, New Delhi, 1980.

Sen, B., Green Revolution in India, New York. 1974.

Shafi, M., Agricultural Productivity and Regional Imbalances - A Study of Uttar Pradesh, New Delhi, 1984.

Spate, O.H.K., India and Pakistan, London, 1953.

Sharma, A.C., Mechnization of Punjab Agriculture, New Delhi, 1976.

Sharma, S., Technological Response in Developing Agriculture, New Delhi, 1982.

Shinde, S.D., Agriculture in Under Developed Region, A Geographical Survey, Bombay, 1980.

Smith, N., Uneven Development, Oxford, 1984.

Subramanian, C., The New Stoategy in Indian Agriculture, Vikas Publishing House, New Delhi, 1979.

Thirupalu, N., Agricultural Finance and Development. Chugh Publications ,Allahabad, 1987.

Srivastava, V.K. (Ed.) Commercial Activities and Development in the Ganga Basin., Concept Publishing Company, New Delhi, 1999.

Yang, W.Y., Methods of Farm Management Investigations for Improving Farm Productivity, FAO, Agricultural Development Paper No.80, Rome, 1968.

JOURNALS

Ahmad, F.A., New Dimensions of Green Revolution, Southern Economics, Vol.9, No.2, 1977.

Ali, M. and Chandra, S., Rhizobial Inoculation of Pulses Crops, Indian Farming, Vol.35, No.5, 1985.

Amani, K.Z. and Mohammad, A., Wheat Production in India: The Regional Dimension, The Geographer, Vol.33, No.2, 1986.

Amani. K.Z. Impact of Technology on Rural Habitat Transformation in Aligarh District, Uttar Pradesh, The Geographer, Vol. 32, No.1, 1985.

Ammar, N.Q., Impact of New Technology on Agricultural Production in Aligarh District, National Geographer, Vol.21, No.2. 1986.

Bahadur, T., Impact of Farm Finance and Resource Productivity in Agriculture, Indian Journal of Agricultural Economics, Vol.55, No.4, 1975.

Bergman, T., Problems of Mechanization in Indian Agriculture, Indian Journal of Agricultural Economics, Vol.18, No.4, 1963.

Bhalla, S., Agricultural Growth, Role of Institution and Infra-stuructural Factors, Economic and Political Weekly, Vol.12, No.45, 1988.

Bhardwaj, R.B.L. and et.al., Irrigate Your Wheat Crop at Critical Stage of Growth, Indian Farming, Vol.20, No.10, 1971.

Bhattacharjee, J.P., Mechanization of Agriculture in India, Indian Journal of Agricultural Economics, Vo.4, No.1,1949.

Bhuleshwar, A.V., Productivity and Technological Changes: A Theoritical Analysis, Productivity, Vol.6, No.2, 1965.

Bonde, W.B., Tractors in Indian Agriculture, Agricultural Situation in India, Vol.24, No.5, 1969.

Chanda, G.K., New Agricultural Technology, Farm Size and Capital Structure, A Region-wise Analysis of Punjab Experience, Indian Journal of Regional Science, Vol.9, No.2.

Chellapan, K., High Yielding Varieties Programme: A Perspective, Rural India, Vo.34, No.11 & 12, 1971.

Chopra, V.L., Biotechnology: Timely Aid for Crop Improvement, Survey of Indian Agriculture, 1990.

Desai, D.K. and Misra, B.N., Technological Change and Rate of Diffusion, Indian Journal of Agricultural Economics, Vol. 21, No.1, 1966.

Dhondyal, S.P., Regional Variations in Agricultural Development and Productivity in Uttar Pradesh, Indian Journal of Agricultural Economics, Vol.19, No.1, 1964.

Durry, K., Improving Agricultural Efficiency Through Fertilizers, The Geographer, Vol.33, No.2, 1986.

Enyedi, G.Y., Geographical Types of Agriculture, Applied Geography in Hungary, Budapest, 1964.

FAO, Raising Agricultural Productivity in Developing Countries through Technological Improvement, The state of Food and Agriculture, 1968.

Folk Dorings, Productivity of Labour in Agricultural Production, Agricultural Experimental Station Bulletin 726, Urbana, University of Illinois, College of Agriculture, September, 1967.

Heptulla, N. Science and Technology for National Development, Yojna, Vol.35, No. 1&2, 1991.

Hsieh, S.C. and Ruttan, V.W., Environmental Technological and Institutional Factors in the Rice Production: Phillippine, Thailand and Taiwan, Food Research Institute Studies, Vol.7, No.3, 1980.

Jain, A., Transfer of Technology for Social Change, Yojna, Vol.35, No.1&2, 1991.

Jain, S.C., and et-al., Biotechnology Based Agriculture and Food Products - A Perspective, Kurukshetra, Vol.39, No.2, 1990.

Kanwar, J.S., Fertilizer - The Kingpin in Agriculture, Indian Farming, Vol.18, No.12, 1969.

Kanwar, J.S., The Role of Machinery in Modernization of Agriculture, Indian Farming, Vol.19, No.11, 1970.

Kayatha, S.L. and Singh, A.K., An Ecological Agro-economic Regionalization of Mirzapur District, The Geographer, Vol.34, No.1, 1987.

Khanna, S.S. and Mittal, V.K., Pest of Paddy and their Control in Uttar Pradesh, Indian Farming, Vol.20, No.4, 1970.

Kumaraswamay, S., Expanding Role of Co-operative in Agriculture, Agriculture Situation in India, Vol.24, No.3, 1969.

Kusum, C., Tractorization and Changed in Factor Inputs, "A Case Study of Punjab", Economic and Political Weekly Review of Agriculture, Dec. 28, 1974.

Lal, S. and Saini, R.S., Technology for Increasing Maize Production, Indian Farming, Vol. 35, No.4, 1985.

Mackenzie, W., The Impact of Technological Change on the Efficiency of Production in Canadian Agriculture, Canadian Journal of Agricultural Economics, No.1, 1962.

Majumdar, A., Soil Conservation: A Technological Change in Indian Agriculture, Agricultural Situation in India, Vol.21, No.4, 1966.

Mann, S.S., Scope for Consolidation of Holdings and Soil Conservation and its effect on Agricultural Production, Indian Journal of Agricultural Economics, Vol.14, No.3, 1959.

Mehta, V.P., The Role of National Seed Corporation, Indian Farming, Vol. 20, No.3, 1970.

Mitra, C., Agricultural Development and Role of Fertilizers, Regional Development and Planning, Calcutta, Vol.8, No.1&2, 1976.

Mohammad, N., Technological Change and Diffusion of Agricultural Innovations, The Geographer, Vol.23, 1969.

Nath, V., Growth of Indian Agriculture: A Regional Analysis, Geographical Review, Vol.59, No.3, 1969.

Nigam, M.N., Trends of Agricultural Development in Uttar Pradesh, The Geographical Knowledge, Vol.2, No.1, 1969.

Notani, N.K. and et al., Engineering Crops to Yield More, Science Reporter, Dec. 1990.

Oommen, M.A., Technological Change and its Diffusion in Agriculture - Is Existing Institutional Set up Adequate, Agricultural Situation in India, Vol.21, No.7, 1966.

Padki, M.B., Consolidation of Holdings, Agricultural Situation in India, Vol.20, No.1-6, 1965.

Pandey, H.K.,Glimpse of Co-operative Movement in India, Agriculture and Agro-Industries Journal, Vol.17, No.7, 1974.

Persley, G., Harnessing Biotechnology for the Third World, Partners in Research for Development, No.3, April 1990.

Petiard, V. and Deshayes, A., Plant Biotechnology as a Tool for Research and Production, Nestle Research News, 1986-87.

Parimala, G. and Qureshi, M.H., Levels of Agricultural Development in Tamil Nadu, The Indian Geographical Journal, Vol.58, No.2, 1983.

Prasad, A.G. and Pothana, V., High Yielding Technology and Productivity - A Study in Interstate Variations in Andhra Pradesh, Indian Journal of Regional Science, Vo.15, No.1, 1984.

Qazi, M.A. and Khan, M.F., Changes in Cropping Patterns of the Punjab Plain, The Geographer, Vol.31, No.1, 1984.

Rangaswami, G., Microbes Enrich Plant Life, Survey of Indian Agriculture, 1990.

Rao, W.R., Role of Space Technology in Social Transformation, Yojana, Vol.35, No. 1&2, 1991.

Rao. V.P., Biological Control of Insect Pest and Weeds, Every Man's Science, Vol.6, No.2, 1971.

Rehman, H., Mechanization of Farming and its Impact of Food Crop Productivity in Uttar Pradesh, The Geographer, Vol.23, No.2, 1976.

Sampath, T.V., New Challenges in Wheat, Survey in Indian Agriculture, 1990.

Saran, R., Production Function Approach to the Measurement of productivity in Agriculture, Journal of the Indian Society of Agricultural Statistics, Vol.17, No.2, 1965.

Savale, R.S., Technological Change in Agriculture Study of Sources of its Diffusion, Efficiency of the Sources and the Economic Factors Affecting the Adoption of Improved Practices, Indian Journal of Agricultural Economics, Vol.21, 1966.

Shafi, M., Patterns of Cropland Use in the Ganga-Yamuna Doab, The Geographer, Vol.12, 1965.

Shafi, M., Can India Support Five Times Her Population, Science Today, Vol.3, No.9, 1969.

Shafi, M., Measurement of Agricultural Productivity of the Great Indian Plains, The Geographer, Vol.19. No.1, 1972.

Shafi, M., Geographer and Society with Special Reference to India, The Geographer, Vol.31, No.1, 1984.

Shafi, M., Perspective in Agricultural Geography with Special Reference to India, The Geographer, Vol.33, No.2, 1986.

Shafi, M., Water Management and Crop Production in India, The Geographer, Vol.34, No.1, 1987.

Shastry, S.V.S., New High Yielding Varieties of Rice - Java and Padma, Indian Farming, Vol.18, No.11, 1969.

Singh, A., Seed Testing - The Key Factor in Successful Seed Production Programme, Indian Farming, Vol.20, No.5, 1970.

Singh H.S., Agricultural Development Towards a Strong

Resource Base, Survey of Indian Agriculture, 1990.

Sridharam, C.S., Farm Machinery Research - A Review Indian Farming, Vol.19, No.11, 1979.

Subbiah, S. and Ahmad, A., Determinants of Agricultural Productivity in Tamil Nadu - India, Transaction Institute of Indian Geographer, Vol.2, No.1, 1980.

Tiwari, R.C. Pattern and Process of Rural Transformation in the Lower Ganga-Yamuna Doab, National Geographer, Vol.16, No.1, 1981.

Wadia, D.N. and Auden, J.B., Geology and Structure of Northern India, Memoirs of the Geological Survey of India, Vol.73, Delhi, 1939.

Directorate of Statistics and Evaluation, Bihar, Patna.

Bihar Aankron Mein - 1971, 1980, 1981, 1990, 1991, .

Bihar at a Glance - 1991, 1992, 1993.

APPENDIX A

	1981	1991
1. Total Population	69914734	86374465
(a) Males	35930560	45202091
(b) Females	33984174	41172374
2. Percentage of Male to Total Population	51.39	52.33
3. Percentage of Female to Total Population	48.61	47.67
4. Rural Population	61196000	75021453
5. Urban Population	8719000	11353012
6. Percentage of Rural Population to Total Population	87.52	86.86
7. Percentage of Urban Population to Total Population	12.48	13.86
8. Density of Population Per sq. km.	402	497
(a) Rural Density	358	N.A.
(b) Urban Density	2726	N.A.
9. Percentage of Literacy to Total Population	26.20	38.48
(a) Male	38.11	52.49
(b) Female	13.62	22.89
10. Number of Females Per Thousand Males	946	911
11. Main Workers	20753128	25619038
(a) Males	17675805	21513704
(b) Females	3077323	4105334
(c) Rural	18501502	22825032
(d) Urban	2251626	2794006
12. Percentage of Main Workers to Total Population		
(a) Total	29.68	29.66
(b) Males	49.19	47.60
(c) Females	9.06	9.97
(d) Rural	30.23	30.42
(e) Urban	25.82	24.61
13. Cultivars	9042000	11164000
14. Agricultural Labour	7367000	9513000

APPENDIX B

INDICES OF AGRICULTURAL PRODUCTIVITY

S. No.	Name of District	Yang's Yield Index	Agricultural Output per Hectare in Rs.
		1980-81	1980-81
1.	Patna	107.69	2417.47
2.	Nalanda	116.27	2613.20
3.	Gaya	77.43	1772.52
4.	Nawada	84.62	2010.42
5.	Aurangabad	76.00	1717.99
6.	Bhojpur	80.50	1997.24
7.	Rohtas	90.13	2369.72
8.	Saran	87.42	1944.32
9.	Siwan	94.95	2128.24
10.	Gopalganj	89.17	1931.69
11.	East Champaran	113.93	2400.61
12.	West Champaran	115.80	2603.28
13.	Muzaffarpur	85.07	1903.57
14.	Vaishali	90.58	1991.11
15.	Sitamarhi	104.56	2696.04
16.	Darbhanga	88.17	1880.09
17.	Samastipur	100.83	2499.76
18.	Madhubani	55.54	1694.81
19.	Begusarai	106.77	2434.76
20.	Santhal Pargana	84.77	1791.87
21.	Munger	78.12	2152.60
22.	Bhagalpur	96.50	1953.81
23.	Saharsa	71.01	1619.21
24.	Purnia	97.58	2238.79
25.	Katihar	81.27	1682.23
26.	Hazaribagh	78.50	1847.95
27.	Giridih	100.57	2234.65
28.	Dhanbad	90.63	1723.57
29.	Ranchi	94.63	2025.81
30.	Palamu	54.96	1253.58
31.	Singhbhum	66.05	1715.83

APPENDIX C

INDICES OF AGRICULTURAL PRODUCTIVITY

S. No.	Name of District	Yang's Yield Index	Agricultural Output per Hectare in Rs.
		1990-91	1990-91
1.	Patna	122.37	5689.85
2.	Nalanda	135.27	6156.15
3.	Bhojpur	127.83	5742.05
4.	Rohtas	126.41	5791.10
5.	Gaya	101.90	4874.33
6.	Jehanabad	111.25	4968.70
7.	Nawada	130.49	5892.50
8.	Aurangabad	84.96	5132.40
9.	Saran	108.98	6614.14
10.	Siwan	106.09	6286.34
11.	Gopalganj	112.98	6043.17
12.	Muzaffarpur	96.34	5577.41
13.	East Champaran	117.79	6934.79
14.	West Champaran	100.17	6095.20
15.	Sitamarhi	96.77	5399.37
16.	Vaishali	106.90	5691.41
17.	Darbhanga	93.53	5658.11
18.	Madhubani	98.53	5619.01
19.	Samastipur	111.75	6616.93

20.	Begusarai	106.65	6422.01
21.	Bhagalpur	81.47	4947.30
22.	Munger	86.82	5376.53
23.	Khagaria	103.119	6329.83
24.	Dumka	94.15	5472.20
25.	Godda	79.44	4539.24
26.	Deoghar	98.38	5892.08
27.	Sahibganj	85.02	4992.57
28.	Saharsa	79.70	4750.83
29.	Madhepura	96.89	5663.91
30.	Purnia	82.92	4975.79
31.	Katihar	90.46	5603.86
32.	Hazaribagh	67.10	4137.02
33.	Giridih	74.61	4587.44
34.	Dhanbad	69.01	4327.92
35.	Ranchi	78.58	4929.32
36.	Lohardaga	77.42	4520.59
37.	Gumla	61.94	3730.02
38.	Palamu	56.43	3394.79
39.	East Singhbhum	51.87	3119.45
40.	West Singhbhum	82.87	3241.73
41.	Kishanganj	82.69	4922.23
42.	Araria	86.33	5154.05

APPENDIX D

VARIABLES OF REGIONAL DEVELOPMENT

Sl. No	Variable Set/Variable	Description
A. Agricultural Development		
1.	Multiple Cropping	Area sown more than once as the per cent of net sown area.
2.	Irrigation	Gross irrigated area as the per cent of the total cropped area.
3.	Fertilizer	Use of NPK Kg/hectare.
4.	High Yielding Varieties	Area under HYVS as per cent of total cropped area.
5.	Tractorization	Number of tractors per 10,000 hectares of cultivated area.
6.	Tube-wells and Pump Sets	Number of tube-wells and pump sets per 10,000 hectares of cultivated area.
B. Urbanization and Industrialization		
7.	Urban Population	Urban population as per cent of total population.
8.	Urban-Rural Ratio	Ratio of urban population to rural population.
9.	Factories	Number of registered factories per 100,000 of population.
10.	Factory Workers	Registered factory workers as per cent of total workers.
11.	Secondary Workers	Secondary workers as per cent of total workers.

12.	Tertiary Workers	Tertiary workers as per cent of total workers.
C. Infrastructure and Amenities		
13.	Road Lenght	Road length in km. per 100,000 of population
14.	Road Density	Road density per 100 sq. km.
15.	Banks	Number of banks per 100,000 of population.
16.	Electrification	Number of electrified villages as per cent of total villages.
17.	Seed and Fertilizer Storages	Number of seed and fertilizer storages per 10,000 of cultivated area.
18.	Hospital and Dispensaries	Number of hospitals and dispensaries per 100, 000 of population.
D. Social Development		
19.	Literacy	Literate person as per cent of total population.
20.	School	Number of schools per 100,000 of population.

APPENDIX E

STANDARDIZED FACTOR SCORES OF REGIONAL DEVELOPMENT 1980-81

S. No.	Name of District	Factor I	Factor II	Factor III	Factor IV
1	2	3	4	5	6
1.	Patna	2.9940	2.7192	1.9595	1.8188
2.	Nalanda	1.6114	0.7228	1.7813	1.5081
3.	Gaya	2.4582	1.6167	-2.1962	1.9279
4.	Nawada	1.8067	0.5169	-0.9848	-0.1783
5.	Aurangabad	2.8464	-1.6859	-1.2128	0.5107
6.	Bhojpur	2.4958	2.3810	0.1738	-1.7626
7.	Rohtas	2.5069	-1.2887	2.0314	-2.5435
8.	Saran	3.9610	-1.2629	-1.0071	-0.7138
9.	Siwan	0.1481	-2.3786	1.3616	-0.3371
10.	Gopalganj	1.0671	-1.7825	0.9900	-1.5485
11.	E.Champaran	1.8254	0.1918	2.3454	-2.3491
12.	W.Champaran	1.8641	-2.9071	1.9613	-2.1937
13.	Muzzarpur	-2.3098	-2.1168	0.3534	-0.0812
14.	Vaishali	2.4422	-1.7934	0.6149	2.3228
15.	Sitamarhi	1.3627	-2.0274	2.4514	-0.8972
16	Darbhanga	-2.8800	-0.5422	-2.0034	-1.2363
17.	Samastipur	0.2538	-2.6513	2.2426	0.0308
18.	Madhubani	0.3267	-2.6308	-1.5029	-0.3860
19.	Begusarai	1.7291	1.7904	1.9222	0.1474

20.	Santhal Parganas	-2.3089	1.3247	-2.8388	-0.5880
21.	Munger	1.0498	2.6800	-0.9768	-0.6612
22.	Bhagalpur	0.4495	0.2300	-0.2470	-0.9496
23.	Saharsa	-2.1316	-1.5329	-2.4725	-1.1597
24.	Purnia	-2.2849	-1.8853	0.4966	-2.4806
25.	Katihar	-2.7655	-2.4424	-1.2170	-0.0620
26.	Hazaribagh	-2.1442	0.2414	-2.0636	-0.5842
27.	Giridih	-2.6800	0.7612	-0.2562	0.7260
28.	Dhanbad	-2.4579	1.8143	-1.5176	1.5421
29.	Ranchi	-2.0297	1.8312	-2.1903	2.3458
30.	Palamu	-2.8312	-0.5513	-2.8827	-0.7073
31.	Singhbhum	-2.9817	1.6070	-2.4236	-2.2047

APPENDIX F

STANDARDIZED FACTOR SCORES OF REGIONAL DEVELOPMENT 1990-91

S. No. 1	Name of District 2	Factor I 3	Factor II 4	Factor III 5	Factor IV 6
1.	Patna	1.6319	2.4671	1.7833	1.6712
2.	Nalanda	1.6775	2.5318	1.6199	0.7846
3.	Bhojpur	1.8428	0.4512	2.1903	2.7707
4.	Rotas	1.3744	0.3210	0.7454	1.5001
5.	Gaya	0.4212	1.6325	2.3153	1.5301
6.	Jehanabad	0.6105	-2.8430	0.6139	-2.4047
7	Nawada	0.6932	1.5212	0.5010	-0.6639
8.	Aurangabad	0.7213	1.6432	1.4446	1.1002
9.	Saran	0.9555	-2.2888	-0.3175	1.5041
10.	Siwan	-0.3261	-1.6177	-0.6515	-1.2998
11.	Gopalganj	0.4364	-2.5732	0.8043	-1.8819
12.	Muzaffarpur	1.016	-1.7353	-0.9772	-0.9326
13.	E. Champaran	2.3018	-1.0212	1.7301	0.2020
14.	W. Champaran	2.7232	-0.4161	1.59393	0.3944
15.	Sitamarhi	1.5575	-1.5201	-1.2541	-2.2033
16.	Vaishali	1.5789	-2.2464	-0.4894	-1.6313
17.	Darbhanga	0.1329	0.4874	-0.6064	-2.4078
18.	Madhubani	-0.3651	-1.4105	-0.6017	-2.9673
19.	Samastipur	1.7068	0.0498	-0.1372	-1.0895

20.	Begusarai	1.206	2.3678	-1.7540	-2.6038
21.	Bhagalpur	-1.7889	-0.0776	2.2103	0.7720
22.	Munger	0.4809	0.3237	1.3107	-1.8720
23.	Khagaria	0.4618	-0.9008	-0.0701	-2.1680
24.	Dumka	-0.6732	-2.4473	-0.0607	-2.1187
25.	Godda	0.4793	-1.5441	-0.2697	-2.2815
26.	Deoghar	-1.0311	-2.1098	-0.2886	-1.6421
27.	Sahibganj	0.5821	-2.0865	-0.6746	-2.8759
28.	Saharsa	1.3123	-0.0161	-0.1731	0.6100
29.	Madhepur	0.9321	-1.3452	-1.7284	-2.0895
30.	Purnia	0.4167	-0.1772	-2.2853	0.7211
31.	Katihar	0.4612	-1.2694	-0.4352	-1.7767
32.	Hazaribagh	-1.6627	1.5562	-1.8997	1.5115
33.	Giridih	-1.8626	-2.8006	1.2286	-1.6622
34.	Dhanbad	-2.2182	1.7848	1.6602	1.5693
35.	Ranchi	-2.4075	2.3509	-2.1173	1.6117
36.	Lohardaga	-1.8710	-2.3509	-0.2570	-2.8092
37.	Gumla	-2.3598	-2.1327	-0.7146	-2.4307
38.	Palamu	-1.5453	-1.8959	-0.8108	-1.4759
39.	E. Singhbhum	-2.1640	1.5735	-2.3681	1.6083
40.	W. Singhbhum	-2.3480	2.3499	-2.3614	1.5231
41.	Kishanganj	0.1606	-2.7521	-1.4437	1.4495
42.	Araria	-0.5619	-1.7137	-1.1390	1.3837

APPENDIX G

COMPOSITE INDEX 1980-81

S. No.	Name of District	Composite Index of Agricultural Productivity	Composite Index of Regional Development
1.	Patna	1442.24	68.60
2.	Nalanda	1406.00	67.48
3.	Gaya	952.45	55.05
4.	Nawada	1078.73	55.28
5.	Aurangabad	923.60	33.64
6.	Bhojpur	1069.94	40.89
7.	Rohtas	1269.29	35.97
8.	Saran	1045.97	44.45
9.	Siwan	1144.56	39.69
10.	Gopalganj	1040.29	32.43
11.	E. Champaran	1294.34	40.02
12.	W. Champaran	1399.86	46.02
13.	Muzaffarpur	1023.51	45.23
14.	Vaishali	1071.59	44.24
15.	Sitamarhi	1240.24	29.30
16.	Darbhanga	1013.12	33.59
17.	Samastipur	1339.18	34.38
18.	Madhubani	901.33	24.89
19.	Begusarai	1308.47	36.89
20.	Santhal Pargana	1055.26	27.87
21.	Munger	965.93	25.41
22.	Bhagalpur	1148.99	32.74
23.	Saharsa	870.19	25.06
24.	Purnia	1202.39	25.63
25.	Katihar	907.70	32.07
26.	Hazaribagh	991.91	33.96
27.	Girdih	760.18	27.92
28.	Dhanbad	933.49	64.52
29.	Ranchi	1091.52	68.95
30.	Palamu	673.69	26.88
31.	Singhbhum	917.63	53.93

APPENDIX H

COMPOSITE INDEX 1990-91

S. No.	Name of District	Composite Index of Agricultural Productivity	Composite Index of Regional Development
1.	Patna	3447.50	92.60
2.	Nalanda	3731.76	83.68
3.	Bhojpur	3481.40	54.65
4.	Rohtas	3510.13	47.58
5.	Gaya	2952.64	74.58
6.	Jehanabad	3012.78	42.95
7.	Nawada	3572.35	71.46
8.	Aurangabad	3100.23	66.84
9.	Saran	3994.75	61.67
10.	Siwan	3697.78	44.37
11.	Gopalganj	3651.05	43.71
12.	Muzaffarpur	3370.38	58.75
13.	East Champaran	3989.82	53.73
14.	West Champaran	3681.22	52.20
15.	Sitamarhi	3264.20	42.52
16.	Vaishali	3442.72	56.99
17.	Darbhanga	3417.45	47.06
18.	Madhubani	2839.11	35.71
19.	Samastipur	3997.52	49.81
20.	Begusarai	3879.04	31.32

21.	Bhagalpur	2968.01	46.24
22.	Munger	3246.55	55.21
23.	Khagaria	2822.55	35.24
24.	Dumka	2306.65	30.16
25.	Godda	2743.44	30.60
26.	Deoghar	2559.17	27.50
27.	Sahibganj	3016.47	26.56
28.	Saharsa	2869.96	40.93
29.	Madhepur	2122.27	35.01
30.	Purnia	3005.63	38.48
31.	Katihar	3383.81	40.79
32.	Hazaribagh	2498.20	43.07
33.	Giridih	2770.28	36.82
34.	Dhanbad	2613.00	80.76
35.	Ranchi	2976.10	84.40
36.	Lohardaga	2975.63	25.41
37.	Gumla	2725.25	23.98
38.	Palamu	2250.79	35.68
39.	E. Singhbhum	2048.72	62.06
40.	W. Singhbhum	1896.74	67.12
41.	Kishanganj	2997.52	34.56
42.	Araria	3113.46	36.75

Appendix I

Correlation Matrix of Twenty Variables of Regional Development, 1980-81

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1 000																			
2	0 446	1 000																		
3	0 513	0 819	1 000																	
4	0 725	0 661	0 689	1 000																
5	0 615	0 505	0 606	0 668	1 000															
6	0 379	0 568	0 486	0 269	0 057	1 000														
7	0 472	0 148	0 007	0 400	0 226	0 074	1 000													
8	0 182	0 090	0 043	0 044	0 135	0 153	0 003	1 000												
9	0 363	0 173	0 233	0 231	0 054	0 096	0 710	0 140	1 000											
10	0 299	0 036	0 228	0 224	0 071	0 067	0 631	0 177	0 889	1 000										
11	0 259	0 478	0 322	0 413	0 146	0 275	0 391	0 019	0 064	0 188	1 000									
12	0 454	0 266	0 133	0 412	0 293	0 068	0 472	0 187	0 147	0 214	0 460	1 000								
13	0 298	0 075	0 014	0 243	0 282	0 070	0 428	0 084	0 361	0 427	0 304	0 335	1 000							
14	0 319	0 114	0 019	0 280	0 224	0 110	0 405	0 096	0 387	0 442	0 323	0 316	0 986	1 000						
15	0 077	0 137	0 359	0 113	0 086	0 482	0 719	0 002	0 552	0 480	0 188	0 306	0 278	0 251	1 000					
16	0 411	0 465	0 487	0 551	0 361	0 560	0 029	0 091	0 010	0 185	0 378	0 218	0 209	0 248	0 389	1 000				
17	0 411	0 072	0 140	0 473	0 340	0 119	0 388	0 123	0 489	0 454	0 188	0 327	0 495	0 506	0 151	0 143	1 000			
18	0 355	0 574	0 576	0 563	0 230	0 569	0 087	0 086	0 168	0 031	0 385	0 167	0 014	0 045	0 279	0 732	0 056	1 000		
19	0 405	0 589	0 489	0 640	0 241	0 443	0 116	0 070	0 037	0 161	0 425	0 241	0 112	0 145	0 003	0 614	0 120	0 912	1 000	
20	0 144	0 142	0 055	0 109	0 257	0 265	0 301	0 049	0 253	0 058	0 045	0 122	0 004	0 025	0 113	0 116	0 229	0 111	0 076	1 000

Appendix J

Correlation Matrix of Twenty Variables of Regional Development, 1990-91

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	1.000																			
2.	0.445	1.000																		
3.	0.504	0.724	1.000																	
4.	0.679	0.731	0.708	1.000																
5.	0.323	0.178	0.329	0.339	1.000															
6.	0.382	0.547	0.664	0.413	0.086	1.000														
7.	0.314	0.265	0.047	0.386	0.009	0.060	1.000													
8.	0.070	0.178	0.102	0.073	0.111	0.078	0.614	1.000												
9.	0.188	0.129	0.403	0.116	0.129	0.380	0.600	0.029	1.000											
10.	0.010	0.202	0510	0.0551	0.209	0.433	0.532	0.111	0.9461	.000										
11.	0.363	0.261	0.041	0.387	0.060	0.099	0.945	0.506	0.585	0.517	1.000									
12.	0.361	0.261	0.001	0.377	0.007	0.103	0.932	0.483	0.637	0.563	0.934	1.000								
13.	0.144	0.027	0.174	0.166	0.340	0.071	0.451	0.142	0.565	0.546	0.452	0.461	1.000							
14.	0.140	0.115	0.149	0.225	0.309	0.074	0.427	0.144	0.554	0.558	0.414	0.438	0.960	1.000						
15.	0.060	0.004	0.058	0.035	0.016	0.98	0.028	0.037	0.111	0.151	0.078	0.069	0.116	0.126	1.000					
16.	0.474	0.521	0.657	0.551	0.051	0.742	0.050	0.333	0.226	0.354	0.023	0.104	0.030	0.037	0.049	1.000				
17.	0.337	0.058	0.086	0.206	0.025	0.027	0.0155	0.749	0.419	0.263	0.119	0.134	0.160	0.132	0.337	0.045	1.000			
18.	0.361	0.110	0.226	0.134	0.082	0.190	0.634	0.015	0.653	0.562	0.651	0.664	0.362	0.341	0.118	0.133	0.545	1.000		
19.	0.034	0.329	0.365	0.115	0.102	0.319	0.238	0.080	0.405	0.374	0.237	0.246	0.109	0.110	0.073	0.209	0.339	0.543	1.000	
20.	0.361	0.093	0.106	0.224	0.309	0.152	0.008	0.135	0.059	0.013	0.071	0.064	0.150	0.137	0.028	0.053	0.371	0.315	0.310	1.000